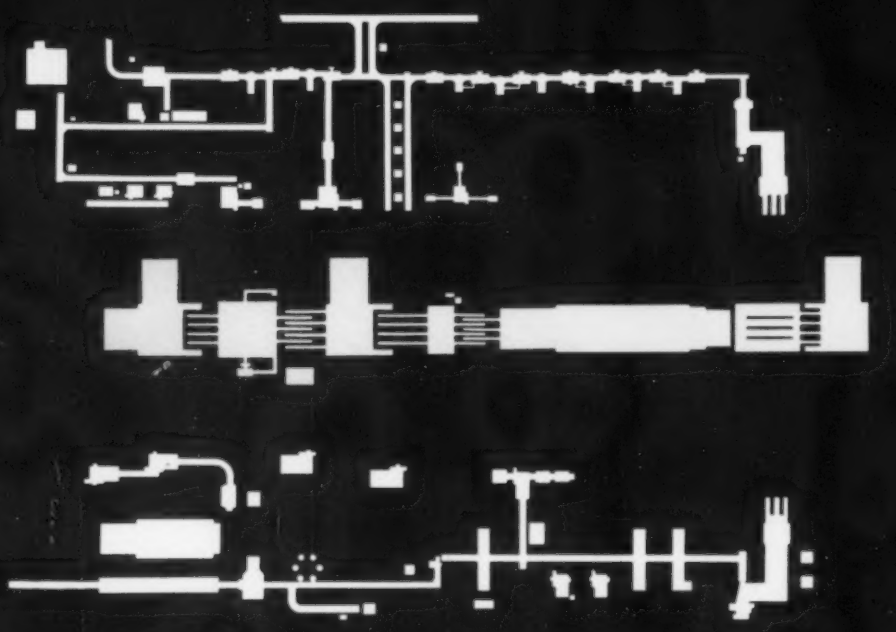
AUTOMATION

SEPTEMBER 1958



Handling Sheet Metal

ON CONTAINER DECORATING LINE

The Magazine of Automatic Operations

- Elements of Automatic Control
- Pneumatic Valve Positioners
- Obsolescence and EDP
- Modular Electronic Assembly

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A PENTON PUBLICATION

Master mechanics like the Wean "Flying Press" as much as presidents do

The Wean "Flying Press" does one thing extremely well: it produces stamped parts at absurdly low costs per piece. This pleases management because the cost reduction it makes possible helps widen the profit spread in finished products.

To find the reason for the master mechanic's satisfaction, we must examine the operating characteristics of the "Flying Press," a difficult job to do in print. First, the "Flying Press" is completely unique among stamping presses, producing parts from coil without stop-and-go indexing at the press. But, far from making the equipment *more* difficult to operate, this "Flying Press" principle eliminates the use of clutch, brake and fly-wheel; all points of potential press break-down! And there's less danger of die breakage with the "Flying Press," both during set-up and operation, since automatic devices to protect the tooling are built-in.

We could go on with a list of many other advantages which the Wean "Flying Press" offers over ordinary designs, but there's just too much to cover. However, we have summarized the general points of superiority in a booklet which we'll gladly send you. If you'd prefer, one of our sales engineers will be glad to discuss the "Flying Press" in regard to your specific production at your convenience.

May we hear from you, to send the booklet or call?

WEAN

WEAN EQUIPMENT CORPORATION

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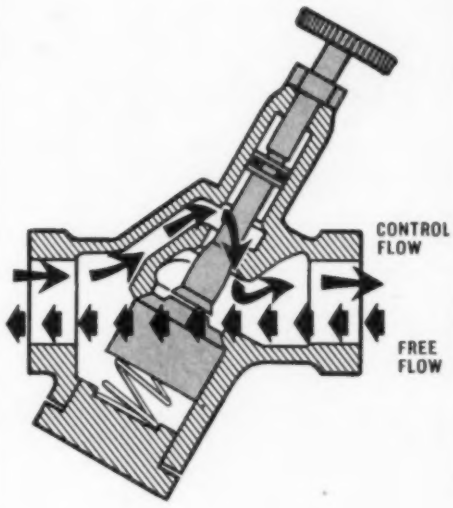
Tranquilize your cylinders

Rx

Ross speed control valves

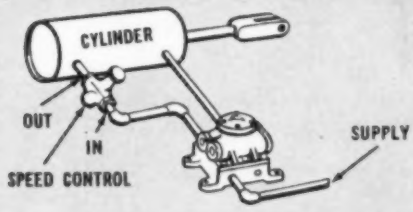


FREE FLOW TO CYLINDER (LEFT)
CONTROLLED FLOW FROM CYLINDER

PRICED WITH THE LOWEST

By keeping full power driving the cylinder but metering the flow from it, you can get smooth, positive and infinitely variable control of the cylinder speed without the problems that come with trying to adjust cylinder movement by varying inlet pressure. This is why speed control valves are so satisfactory for making cylinders act right. And why do so many specify Ross speed controls?

Simply this. When you turn the adjustment screw things don't "just happen." Instead, you force the air to flow through a carefully engineered variable orifice, an orifice designed to create fine shadings of control at both high and low flow rates. And, this performance is yours in a valve that is designed and built to thrive under rough conditions and still be around for a long time. This valve's only moving internal part is its poppet. You can lock its adjustment against tampering. It mounts in any position. Its aluminum alloy body gives heavyweight performance with welterweight bulk. Join the thousands who profit by using Ross speed control valves.



The speed control valve as used between a 4 way valve and a cylinder, shown above, regulates (slows down) the piston rod retraction.

FULL RANGE IN STOCK

3 ADJUSTABLE HEAD STYLES AVAILABLE, KNOB, PIN OR SLOT

ALUMINUM ALLOY BODY

BUBBLE TIGHT POPPET

PIPE SIZE ¼, ⅜, ½, ¾, 1, 1¼

Call your nearby Ross Valve engineer or write us.

Ross OPERATING VALVE CO. 131 East Golden Gate • Detroit 3, Michigan

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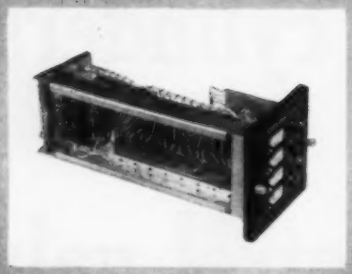
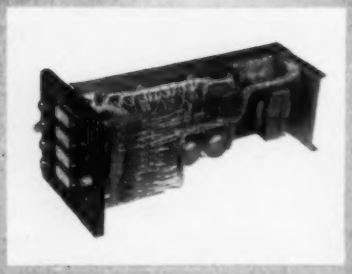


PRINTED CIRCUITRY INCREASES RELIABILITY AND FLEXIBILITY.



USE OF THE HIGHEST QUALITY COMPONENTS INCREASES RELIABILITY . . . ASSURING MAINTENANCE-FREE OPERATION.

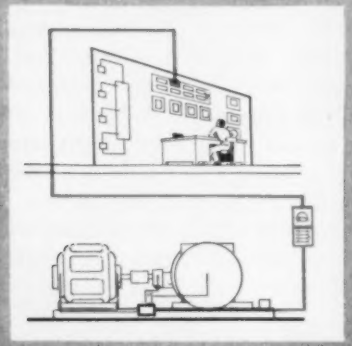


DIAGRAM SHOWS TYPICAL OMNIGUARD SYSTEMS.

THOMAS A.

EDISON

New printed circuit model 310 omniguard temperature monitor

New Versatility . . . and *proven reliability* in temperature detection is made available with the introduction of the new Model 310. Printed circuit design and quality components guarantee a minimum of maintenance for the life of the unit.

Now, you have a temperature monitoring system incorporating all the flexibility, simplicity, quality and economy instrument and systems engineers have needed. The Edison Model 310 is a *mass produced* system whose modular construction makes it possible to have *custom-tailored* installation. Other important features of the new Omniguard Model 310:

- Design keeps pace with growing instrumentation.
- Eliminates corrective maintenance and downtime.
- Complete Unit plugs in.
- Designed for more than a million operations.

Call or write for more complete information.

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INSTRUMENT DIVISION

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SEPTEMBER 1958
Vol. 5—No. 9

AUTOMATION®

A PENTON PUBLICATION

The Magazine of Automatic Operations

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automation outlook

OBSOLESCENCE A MINOR FACTOR

". . . one of the common reasons for postponing the acquisition of an electronic data processing (EDP) system, or of renting instead of buying, is a feeling that equipment for such systems becomes obsolete rapidly. What are the facts? . . . if a computer has been selected to fulfill the needs of the company for the desired planning period, technological obsolescence cannot be expected for 8 to 10 years . . ."—*Roger L. Sisson, Canning, Sisson & Associates,* *see page 75.*

BONUS BENEFITS

". . . quests for cost-saving manufacturing methods lead naturally to consideration of automation. Often, in the accomplishment of more automatic operation, benefits in addition to those needed to justify the equipment are obtained. For example, the planning necessary for effective automation of operations may reveal opportunities to simplify the product or adopt more efficient production processes in its manufacture. Also, improvements in product quality, which were not originally contemplated, are a frequent result of automation . . . "—*Paul L. Deschenes, supervisor, Advanced Manufacturing Engineering, General Electric Co.,* *see page 79.*

PAPERWORK BOTTLENECK

". . . though the day of voice controlled computers and even adequate character reading equipment may be well in the future, the problem of input and output devices of higher speeds of operation and of industry-tailored design is an immediate one, and the next few years must and will see significant innovations and advances in this field. When the speed and efficiency of the large capacity rapid access storage and input and output equipment become compatible with the speed of present day computers, the business world will truly have a powerful weapon to combat the rising tide of paper now engulfing them . . ."—*Alan H. Stillman, mgr., Bizmac Product Planning, Radio Corp. of America.*

ELECTRIFICATION INCREASING

". . . twenty years ago, 7 per cent of the purchase price for a piece of factory equipment such as a machine tool would be represented by electrical parts and components. Three years ago this portion had increased to 12 per cent. Today it is not unusual for a machine tool with special tape controls which will automatically start, stop, and operate the machine to contain 40-50 per cent electrical content and still pay its way . . . In time, it is conceivable that the electrical and electronic content of advanced automation machines may even exceed 50 per cent . . ."—*C. W. Bryant, manager, Materials Service, General Electric Co.*

COMMON DENOMINATOR

". . . the common denominator in an amazing percentage of business problems is materials handling. Whether or not it is recognized as a factor, this element is present, to some degree, in almost every problem area of management. Even though a given management function may appear to be far removed from actual contact with a materials handling problem, it is influenced to a significant degree by the proper use of materials handling equipment and principles at the scene of the problem . . ."—*James R. Sebastian, president, Rapids-Standard Co. Inc.*

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BPA NBP

DRILLED 56,000,000 HOLES SAVED $140,000

that's automation with ARO PAR-A-MATIC DRILLS at progressive Michigan firm!

Running two years, ARO Par-A-matics have drilled 56 million holes in compressor pistons *without trouble* at a growing Michigan company.

Hole sizes: 1/16", 1/8". *Pistons drilled:* 7,000,000.
Savings: 2¢ direct labor per piston.

Let ARO Field Engineers help you automate your drilling with multiple Par-A-matic installations. Drill any number of holes at a time. Simple set-up . . . air-operated . . . adjustable stroke length . . . variable rate of feed. Write for bulletin 5546-T.

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Also Air Hoists . . . Automation Tools . . . Paint Pumps . . . Material Handling Pumps . . . Industrial Lube Equipment

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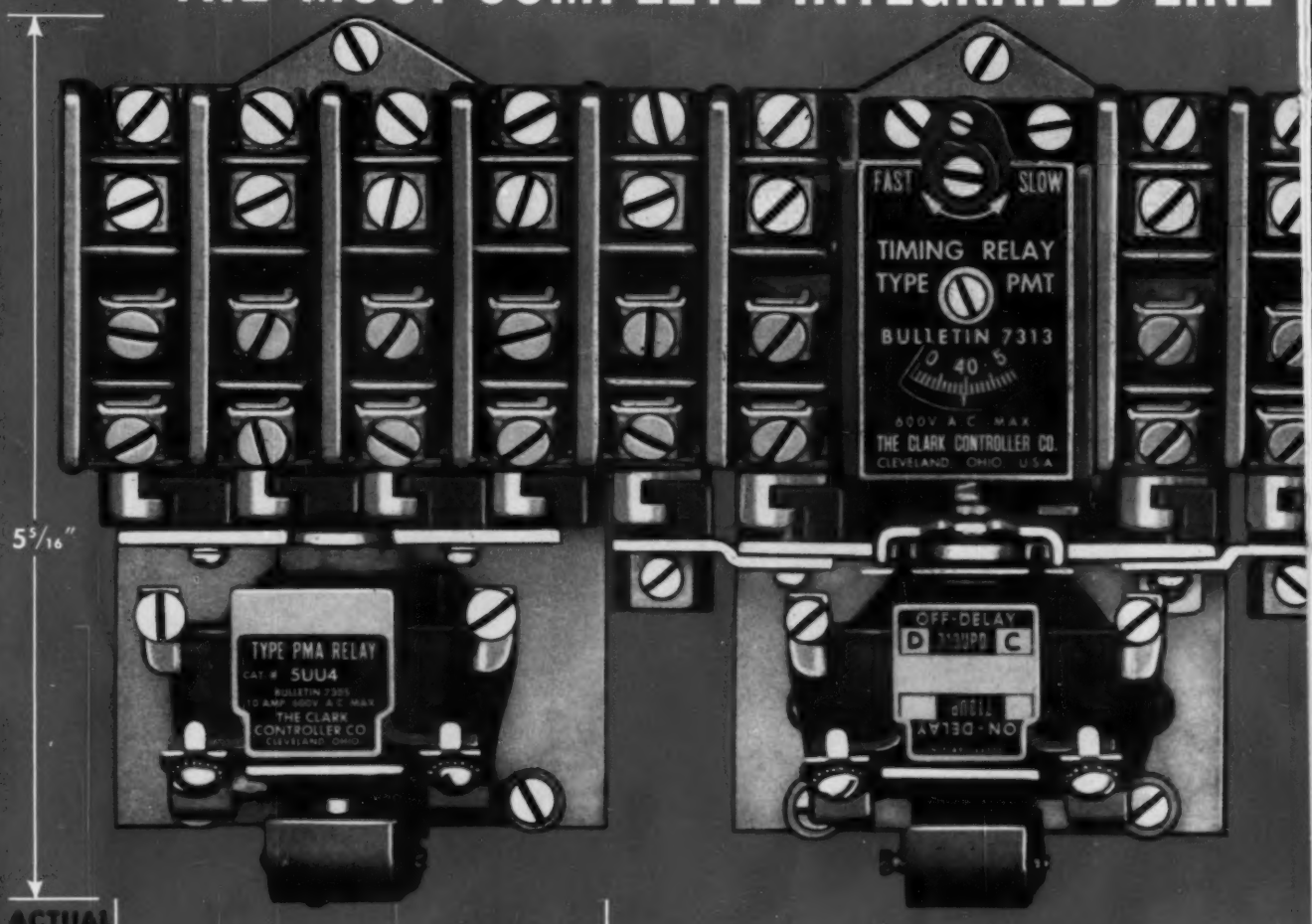
NOW CLARK OFFERS:
THE MOST COMPLETE INTEGRATED LINE



UNIVERSAL POLE RELAYS

UP TO 14 CONTACTS PER RELAY

New Clark Universal Pole Relays now double the available number of contacts per relay. Each universal pole contains two isolated contacts—one normally open, one normally closed. Melamine barriers and spacing provide 600-v clearance between contacts. Contact specifications same as for other "PM" relays: 10 ampere rating, wiping action, same spring pressure and contact opening. Universal poles are interchangeable with convertible poles of "PM" relays. These relays, combined with the others shown above, now provide a range of integrated control relays covering practically every requirement, in minimum panel space.

Line up with other Clark relays on a panel!

TIME DELAY RELAYS

2 or 4 TIMED CONTACTS — up to 6 INSTANTANEOUS CONTACTS

New Clark Pneumatic Time-Delay Relays are designed for modern panels. They match physically other relays in the Clark "PM" line, with the same modular design. Timing head occupies the space of 2 poles above magnet. Universal poles each have isolated normally open and normally closed contacts, with 600-v clearance, saving panel space by doubling the number of contacts per pole. Timed and instantaneous poles are identical. Available for "ON-DELAY" or "OFF-DELAY" operation (time delay after energization or de-energization). Easily convertible by reversing magnet.

Line up with other Clark relays on a panel!

Write for Complete Information

Detailed descriptive bulletins are available for all relays in the Clark "PM" line. Contact your nearest Clark sales office or write us direct.

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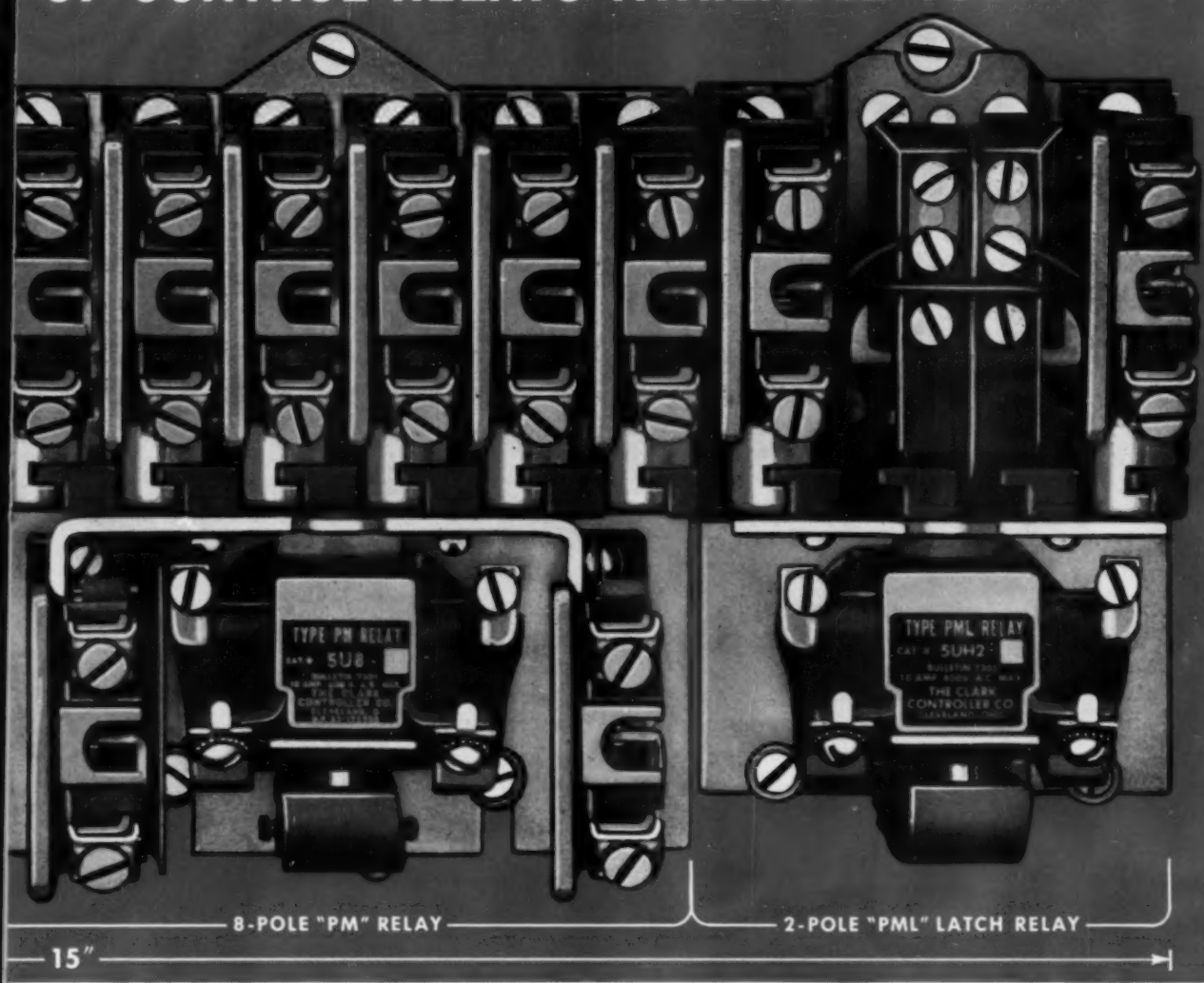
OF CONTROL RELAYS AVAILABLE TODAY!



CONVERTIBLE POLE RELAYS

2 TO 12 POLES

The original line of space-saving control relays featuring exclusive Clark "sectional-pole" or "modular construction". Revolutionary design provides 10 standard units, with 2 to 12 poles, from 5 basic models. Stocking of relays and spare parts is greatly simplified. Poles are easily converted from normally open to normally closed and vice-versa. Single deck models, with 2 to 8 poles, have identical mounting dimensions. Double-deck models, 6 to 12 poles, have mounting dimensions identical with NEMA size 1 starters. Individual poles are front removable without disturbing wiring.

Line up with other Clark relays on a panel!

LATCH RELAYS

2 TO 10 POLES

New Clark mechanically-held, latched-in relays have same modular design as "PM" relays—with latch unit occupying the space of two poles above magnet. No increase in height—saving panel space. Latch unit has its own *continuous duty* coil, allowing one more pole for circuit use since a relay pole is not needed to cut out coil when energized for sustained periods. As with all Clark relays illustrated, extra poles, coils, magnet assemblies and other components are available in kit form—a time saver for maintenance men.

Line up with other Clark relays on a panel!

The **CLARK CONTROLLER** *Company*

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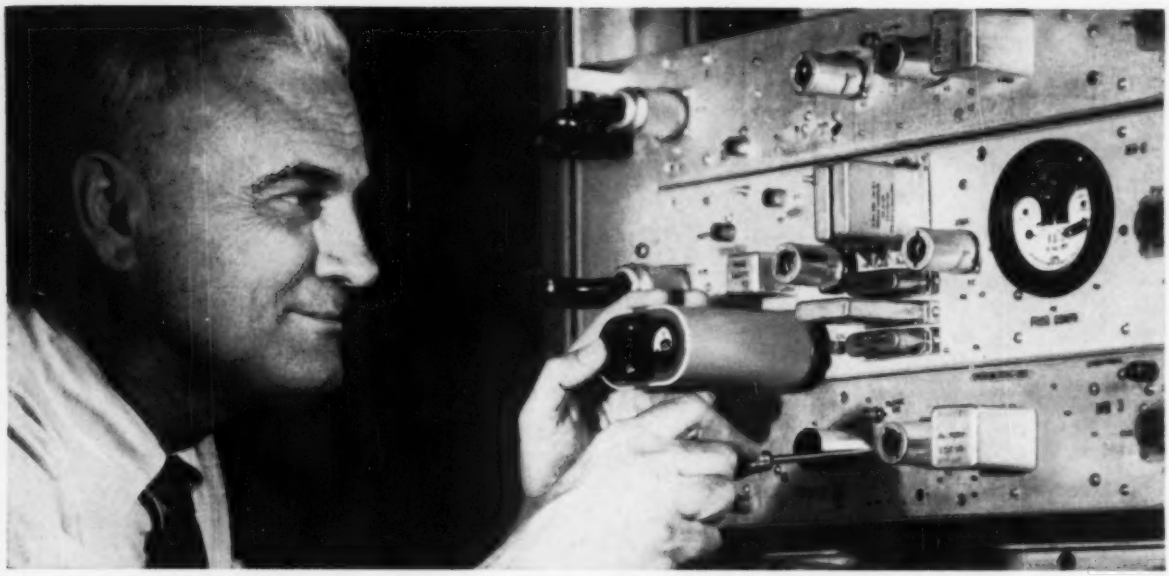
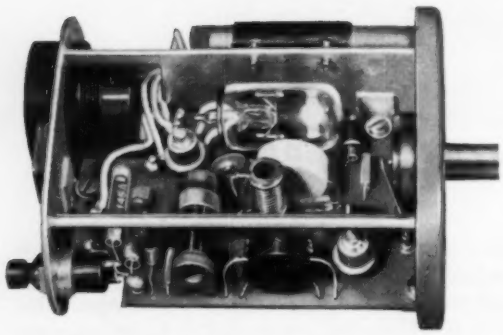
Bell Laboratories Announces Pocket-Sized Frequency Standard for Microwave Systems



Lawrence Koerner, who developed the portable frequency standard, demonstrates how the device can be plugged in at a radio relay station to supply a checking frequency. Battery-powered, the device maintains precision calibration for several months.



Inside the portable frequency standard. Four Laboratories-developed devices make it possible: (1) transistor, which converts the power from a battery to radio frequency oscillations; (2) voltage reference diode, which maintains constant voltage; (3) piezoelectric crystal unit of superlative stability; (4) thermistor, which corrects for temperature variations.

Microwave radio relay systems depend critically on the accuracy of their "carrier" frequencies. At scores of relay stations along a route, carrier frequency oscillators must be checked periodically against a signal from a precise standard.

In the past, the maintenance man has had to obtain his checking frequency by picking up a standard radio signal from a government station. This operation takes time—and requires elaborate equipment.

With a new *portable* frequency standard developed by Bell Laboratories engineers, the job is much simplified. To check an oscillator, the portable standard is plugged in, and a button is pressed. In seconds, it supplies a checking frequency accurate to one part in a million.

Until now, such precision in a frequency standard has been obtainable only in a laboratory. The new portable standard makes it available for routine use in the Bell System. First use of the standard will be to maintain frequency control in a new microwave system for telephone and TV, now under development at Bell Laboratories.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

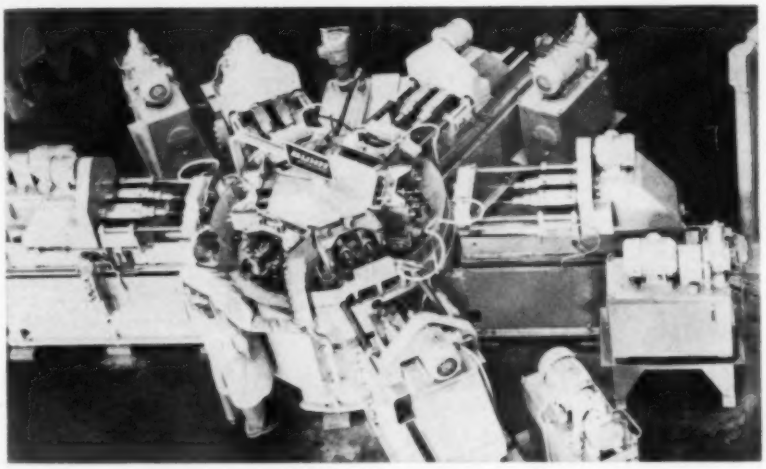
AUTOMATION news

Today's events and developments in the field of automation

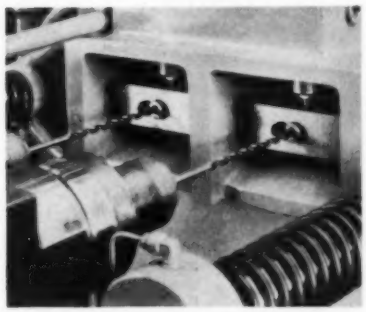
Automatic Machine Uses Five Drills For Single Deep Hole

AUTOMATIC drilling machine developed by Buhr Machine Tool Co. is being used by an automotive parts manufacturer to drill deep holes into steering-gear housings. What makes the installation unique is that the ¼-inch diameter by 7¾-inch deep holes are automatically drilled with five decreasing size drills in order to reduce drill breakage to a minimum.

The drilling machine consists of five dual-spindle drilling units arranged around an automatic six-position index table. Two housing parts are hydraulically clamped in each holding fixture and drilled simultaneously. Since the ¼-inch hole in each housing is an oil passage and not critical, the hole is partially drilled to a different depth at each of the five stations with decreasing twist drill sizes until the full depth is reached at the last station with a ¼-inch drill. By gradually decreasing the drill diameters in this manner, rubbing and chip packing—which cause most drill breakage—are held to a minimum.



DRILLING of deep holes in automobile steering-gear housings is accomplished in five separate drilling operations on this automatic machine designed and built by Buhr Machine Tool Co. Six-station index table progressively moves two parts at a time to five drilling stations where the drill diameter decreases as the depth of the drilled hole increases. Final station drills a ¼-inch hole to complete the full hole depth of 7¾ inches.



DRILLS are supported by bushings to prevent whipping during withdrawal. Proximity switches which check drills against breakage in the drill holes are visible above the bushings.

Automatic cycles for each of the hydraulic-feed drilling units include rapid forward, feed, positive stop, and automatic reverse. Each station requires 27 seconds for its cycle of operation, but at each station different times are used for steps in the cycle to produce optimum operating conditions for each drill size. Bushings guide the slender drills during the drilling stroke. A second support bushing to the rear of the guide bushing prevents the drills from whipping and breaking during retraction and part indexing.

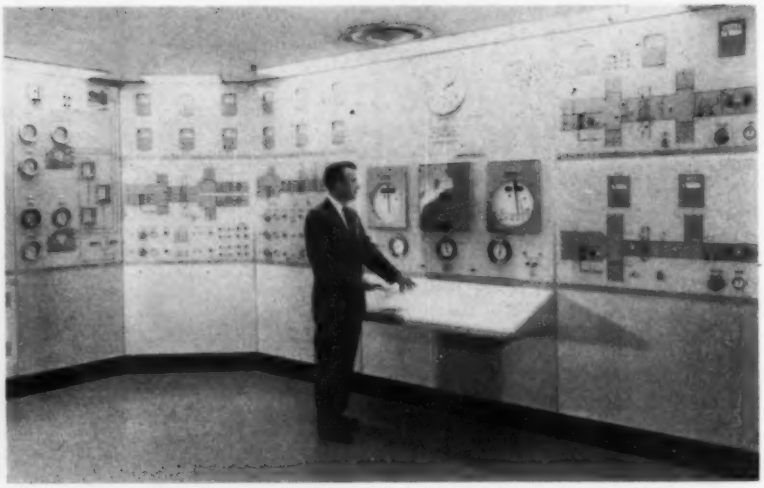
To continuously check the drills against breakage, a proximity switch pick-up is located at a set distance from the drill and between the two bushings. When the drill is fully retracted, its point comes under the midpoint of this pick-up. The metal of the drill provides a path for flux lines which initiate an electrical circuit. If the drill is broken in the work, the circuit is broken upon drill retraction and shuts down the machine. Proximity control units are reset by replacing the broken drill. When the proximity control circuit is again closed, the control relay automatically closes, and the machine is ready for operation again.

Oscilloscope Displays Forty Signals Simultaneously

BAR GRAPH oscilloscope which displays up to forty separate signals simultaneously on a cathode-ray tube has been developed by Federal Instruments Group, Industrial Products Div., International Telephone and Telegraph Corp. The ac oscilloscope permits continuous visual monitoring of multichannel data from thermocouples, strain gages, piezoelectric pressure gages, flow meters, spectrometers, and

other measuring devices.

The oscilloscope presents its display as a vertical bar graph 9 inches high by 12 inches wide on a 17-inch cylindrical cathode-ray tube. Height of each line is a linear function of the input signal level, and the lines are terminated with a dot at the top and at zero for increased reading accuracy. A transparent reading overlay provides 40 vertical identification lines and 100 evenly spaced horizontal lines with every tenth line double width. A switch for each channel permits any one of the 40 signals from the display to be connected to an auxiliary oscilloscope for waveform analysis.



CENTRAL CONTROL PANEL, applying the concept of one-location control which is widely used in industrial plants, has been built into the new Reynolds Metals Co. general office building in Richmond, Va., to control heating, ventilating, and air-conditioning systems. The 32-foot aluminum control board allows a single building engineer to continuously check and log temperatures and other data from all parts of the building, to adjust remote equipment and control devices, to start and stop equipment, to make basic adjustments in temperatures in all areas, and to supervise flow in the fire alarm sprinkler system. Schematic layouts of various equipment systems are shown on the panel with control instruments located in appropriate parts of the layout. The centralized data center was developed by Minneapolis-Honeywell Regulator Co.

Increased Instrument Sales Counter Business Trend

INDUSTRIAL and laboratory instrument sales during the second half of 1958 are expected to equal the comparable period of 1957 for which a total of about $1.5 billion is indicated, the Scientific, Motion Picture, and Photographic Products Div. of the Business and Defense Services Administration, U. S. Department of Commerce, has announced.

Running counter to the downturn in expenditures for plant and equipment by business as a whole, this would be an increase of 12 per cent above the $1.3 billion estimate for the first half of 1958.

The forecast is based on an analysis of the factors which influence instrument sales as well as the relative importance of each user industry to the instrument industry, the Division explained, amplifying that in addition to capital spending, instrument sales are affected by changes in outlays for research and development, the Government's aircraft and missile programs, and the developments in related fields such as electronics.

In summing up, the Division said that the continuing increases in the range, precision, application, and reliability of instruments has opened up entirely new fields, and that the rate of growth of the instrument industry will continue to run ahead of the rest of the economy. The

Instrumentation In All Fields To Be Covered At ISA Show

MARK the dates of September 15-19 on your calendar pad if the technology of instrumentation and automatic controls can be applied at your company or your job. These are the dates of the 13th Annual Instrument-Automation Conference and Exhibit to be held in Philadelphia under the sponsorship of the Instrument Society of America.

Technical Sessions at this year's conference will include more than 80 authoritative technical papers covering feedback control systems, chemical and petroleum instrumentation, liquid pipeline instrumentation, nuclear instrumentation, metals and ceramics instrumentation, aeronautical instrumentation, analysis instrumentation, electronic instrumentation, physical and mechanical measurements, and management and economics. Concurrent with the Technical Sessions will be a series of clinics and workshops discussing instrument maintenance, sales engineering, data handling, control systems, and computers.

Supporting the Technical Sessions and clinics will be over 400 exhibits by leading companies in the industry. Spurred by a predicted business upturn this Fall, exhibitors will be showing their latest products. Included are many manufacturers of data handling equipment whose displayed equipment will be discussed in the Technical Sessions.

The Instrument Society of America is the only technical group of its kind in America devoted exclusively to the technology of instrumentation and automatic controls. It is dedicated to advancements in these fields and their applications to every segment of industry and the military. The Society has over 10,000 members.

Adjusting grinding speed is a simple twist-of-the-wrist with Cleveland Speed Variator

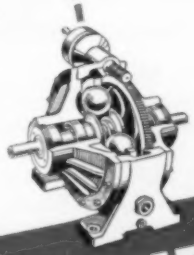
Curtis Machine Division, The Carborundum Company's Contact Wheels and Rolls used with abrasive belts for polishing and precision grinding, must themsevles be ground to tolerances and balance . . . at the precise speed HP for the specific application.

Cleveland Speed Variator, with continuous speed progressions over its full 9:1 range, provides the necessary changes of speed instantly, smoothly. Variator can be adjusted manually or by remote control.

If speed variation is important in your operations, now's the time to learn more about Variator. Send today for Bulletin K-200.

The Cleveland Worm & Gear Company, Speed Variator Division, 3265 East 80th St., Cleveland 4, Ohio.

Sales representatives in all major industrial markets.
In Canada: Peacock Brothers Limited.



HOW IT WORKS

Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts. Relative speeds of the shafts are adjusted by changing the positioning of the axles on which the balls rotate (see cutaway view, right).

CLEVELAND SPEED VARIATOR

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laboratory and industrial instrument industry has been showing an average annual growth of approximately 15 per cent, which is about five times that of the economy as a whole.

Two Handling Societies Plan Future Merger

MERGER of the American Material Handling Society Inc. and the Society of Industrial Packaging and Materials Handling Engineers has been recommended by a joint merger committee of the two societies.

Memberships of both organizations are composed of persons interested in the advancement of the science and theory of materials handling and industrial packaging. AMHS has an international membership of 6000 in 46 chapters in the United States and Canada. SIPMHE has a membership of 1500 in 21 chapters in the U. S.

The merger of the two groups has been under discussion for some time. **W. E. Kappler**, president of AMHS, and **John Mount**, president of SIPMHE, announced the committee's recommendations and stated that a number of formalities, in addition to approval by the societies boards and memberships, would have to take place before the merger could be effected.

Metal Finish Can Be Applied Prior To Forming Operations

ORGANIC finish which can be used in place of plating and anodizing to provide color on metals has been developed by Permatron Co. Material requires only normal pretreatment of metal and can be applied in one coat by spray, dip, or roller coat methods. After the finish is applied to any chemically clean, polished metal, it is baked at temperatures between 325-400 F for 7-15 minutes.

Although the new finish offers savings ranging from 50 to 80 per cent when compared to raw material, labor, and equipment used for plating and anodizing operations, its real value to automation is that it can be applied at any point in a production line. The material will withstand repeated impact without chipping or flaking, and products can be formed after it has been applied. In addition to being resistant to fading and color deterioration, Permatron finishes will not craze or chalk. Final cleaning of the finish on the end of an assembly line should be relatively easy for it is chemically inert and provides resistance to soaps, detergents, alkalies, and acids.

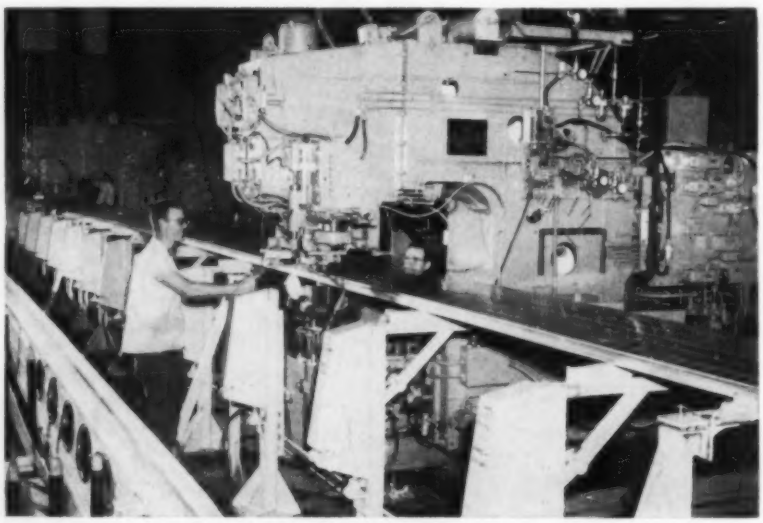
The new material is available in brass, gold, copper, bronze, and a variety of colors. Where it is used to simulate a metal, the finished product is virtually indistinguishable from the metal being duplicated and has added advantages of being nontarnishing and requiring minimum maintenance.

Middle Management Salaries Rise 4.8 Per Cent In 1958

SALARY of the average business executive in the middle management category increased 4.8 per cent—from $11,240 to $11,800 a year—according to the seventh annual survey of middle management compensation conducted by the American Management Association. This is a smaller increase than was reported in last year's survey and apparently reflects the leveling off in business activity that developed in the latter part of 1957.

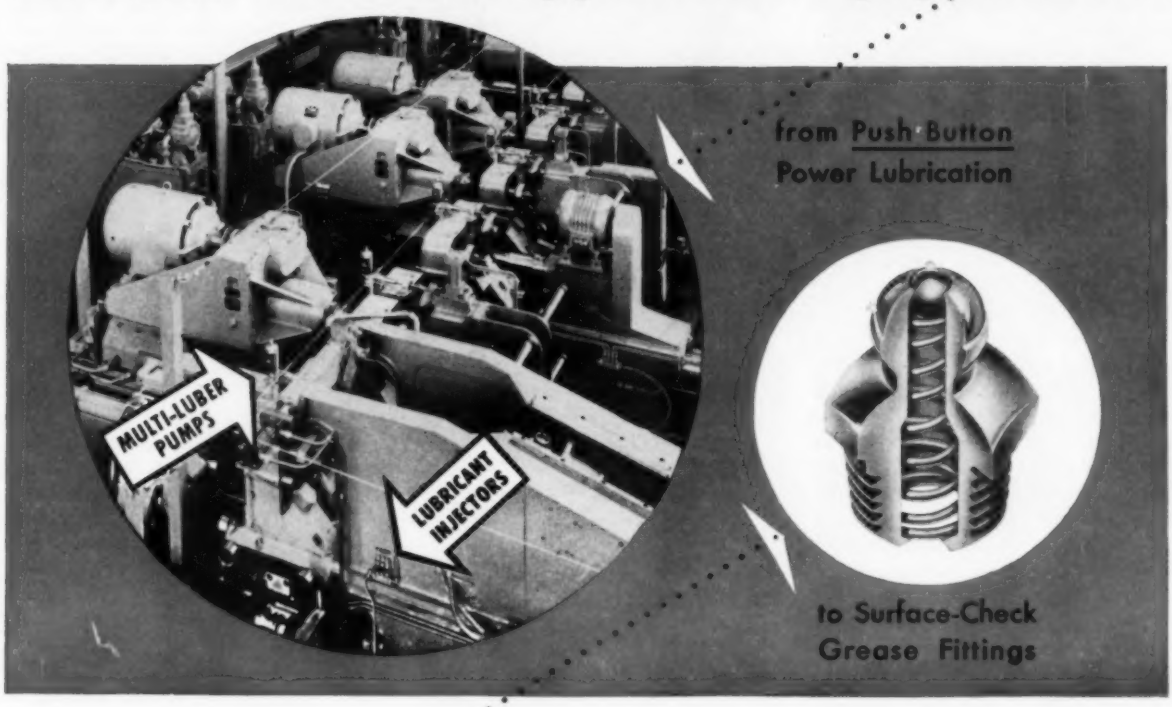
The survey covered the compensation paid to more than 8100 executives in 286 companies throughout the United States and Canada. These executives hold such titles as plant manager, regional sales manager, chief accountant, labor relations manager, general attorney, and product development engineer in the fields of marketing, production, finance, law, purchasing, industrial relations, engineering, and research. Included are 46 types of positons in the category of middle management, between top policy-making level and that of lower supervisory management.

Although salary levels increased during the period covered by the survey, bonuses were paid to only 37 per cent as compared to 45 per cent the preceding year. In small American companies, middle management salaries usually range from about $6000 to about $15,000 a year, while in large companies they may go as high as $30,000, the AMA report shows. Factors other than company size have a decided effect on salary levels. For instance, the salary level of a plant manager is related to the production volume of his plant, and that of a district



NUMERICALLY CONTROLLED riveting machines are being used at Boeing Airplane Co. to fabricate wing panels for the B-52 Stratofortress. Four machines make up the assembly line which can handle wing panels as large as 75 feet long and 4 feet wide. Each tape-controlled machine automatically drills and countersinks a hole, inserts a rivet slug, upsets both ends, shaves off the outer head, and then moves to the next rivet. Eight to ten rivets per minute are driven, fastening stiffeners to lower wing panels. The large riveting machines mounted over the work roll back and forth on floor rails.

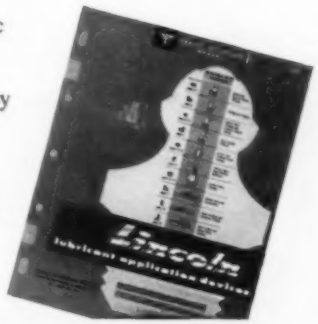
To save down-time reduce production costs, select the right *Lincoln* Lubricant Application Equipment . . .



Everything in lubricating equipment to solve your preventive maintenance problems

Factories, mills and mines, coast-to-coast, look to Lincoln for the solution to *all* kinds of lubricant application problems. Whether it's a low-cost automatic system for original equipment or positive, dependable maintenance of existing facilities, Lincoln provides tested, proven solutions that slash maintenance and operating costs . . . end lubrication down-time . . . boost production efficiency . . . and extend equipment life. Lincoln offers a complete line . . . from famous Bullneck* Surface-Check grease fittings to a complete range of quality automatic centralized lubrication systems.

You pay nothing extra for this quality. So, specify Lincoln equipment, backed by almost half a century of engineering experience. Sales and Service available through a coast-to-coast network of leading industrial distributors.



Contact your local Lincoln distributor now . . . and write for new Lincoln Catalog 92 and Catalog 811.

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Lincoln

LINCOLN ENGINEERING COMPANY
Division of The McNeil Machine & Engineering Co.
5794 Natural Bridge Avenue • St. Louis 20, Missouri

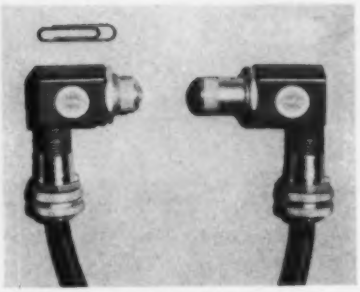
Circle 659 on Page 161

sales manager correlates with the volume of sales in his district. Geographical location does not seem to be a significant factor, other than between the United States and Canada.

Molten Metal System

VARIETY of equipment has been combined to provide a highly automatic stereoplate remelting system for newspaper installations. Central furnace for system was designed by Industrial Heating Dept. of General Electric Co.

Conveyor delivers metal pigs and used plates to a metal supply tank which contains a special electric immersion heater. Voltage for heater can be varied within limits to meet special operating conditions. Molten stereotype metal at correct temperature is pumped from the central tank through seamless steel pipes to various casting pots. The pumps—one for each casting pot in the system—are a special centrifugal type which are capable of sustaining high delivery rates against a head of several feet of liquid metal. Motors which drive these pumps are controlled by a float switch in the casting pot. Uniform temperature of metal in the pipelines joining the control tank to the casting pots is provided by special thermostatically controlled pipe heaters.



PHOTOELECTRIC sensing device developed by Post Electronics, Div., Post Machinery Co., requires a minimum of space for mounting on machinery and equipment. Smallness of units is shown by comparison with a standard paper clip. Transmitting unit light source has an average life of 5000 hours. Photosensitive semiconductor is used in the receiving device. Units may also be used as a reflected beam sensing device.

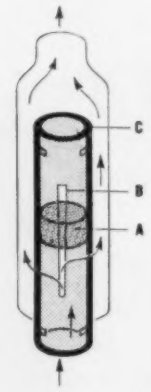
Increased efficiency, reduced operating costs, economical metal storage and melting, and improved plate quality have resulted from use of the new system.

Mechanized Grinding Wheel Plant Under Construction

CONSTRUCTION has started in Niagara Falls, N. Y. on a new plant to manufacture 4 to 14-inch grinding wheels according to an announcement by **General Clinton F. Robinson,** president of the Carborundum Co.

The new plant will incorporate the results of over 2 years of engineering development. Although the plant will not be completely automatic, it will feature specially designed automatic and semiautomatic equipment. For example, abrasive grains and bonds will be weighed automatically according to order specifications. After being mixed under punched card control, the material will move to premix storage. As production control requires, the premix will be carried to automatic presses by special handling equipment. After forming, pressed wheels will be placed on kiln tile with special equipment and will be fed into continuous tunnel kilns where the bond will be melted and vitrified around the grain particles. The wheels will then be processed through machines that automatically finish and place lead bushings in them according to order specifications.

As an indication of the production rate of the new plant, one machine, accomplishing six operations in automatic sequence, will produce 4-inch diameter wheels at the rate of one every 17 seconds. General Robinson said the new plant equipment and processes obsolete not only much of the old plant equipment, but also obsolete many of the former union contract provisions and labor relations practices. The new plant facilities were authorized by the company after the union had agreed to new contract provisions which made it practical to build the mechanized plant.



VARIABLE AREA flow meter developed by C-Mar Corp. uses a tapered orifice to indicate flow through the meter. Diagram shows the operating principle of the meter. Measured fluid (gas or liquid) enters the bottom of the meter, raising float (A), and opening a flow passage through the tapered orifice (B) in the side of an inner tube (C). Fluid flows through the portion of the orifice under the float into an outer tube and out of the top of the meter. For a given flow rate, the float reaches a stable position when the pressure difference across the orifice balances the weight of the float. Due to the tapered shape of the orifice, float height is always directly proportional to the flow rate. Capacity depends on the specific gravity of the fluid, size of flow tube, and float weight. Standard meters range from 0.0001 to 30 gpm of water or 0.0002 to 90 cfm of air. For other capacities and fluids, interchangeable floats are supplied.

Valve Design Provides Resonant Load Damping

IMPROVED closed loop dynamic performance in inertia-loaded servo systems is possible with new pressure feedback valve recently announced by Moog Valve Co. Inc. The valve feeds back cylinder differential pressure internally through a frequency-sensitive hydraulic network, resulting in controlled dynamic pressure-flow characteristics which introduce effective damping. Sensitivity of flow to load pressure can be tailored to provide optimum damping for a particular load.

Although the technique is similar in effect to that achieved by use of a piston bypass orifice with a standard flow control valve, the characteristics of the new valve are more linear, and the power dissipation

ERIEZ

MAGNA-RAIL UNITS SPEED UP CONVEYOR LINES, CONSERVE VALUABLE FLOOR SPACE!

Small, lifetime-powered magnetic automation elements fastened under conveyor belts provide safe, positive hold for ferrous parts; swiftly convey, control and elevate up inclines as steep as 80°; increase safety conditions and reduce damaged parts.

NEW DESIGN FOR GREATER EFFICIENCY! Magna-Rail sections enclosed in a sturdy, extruded aluminum housing are now available. Prevents tampering with magnetic elements; assures ultimate magnetic strength at all times; greatly increases the physical strength of the unit. It's another *first* from Eriez—*always first* in magnetic research and design!

Speed up production and reduce operating costs with Eriez Magna-Rail! These units, fastened under existing lines or incorporated into new ones, turn ordinary belt conveyors into **magnetic** conveyor-elevators that are able to move ferrous materials and parts at greatly increased speeds.

Powerful magnetic action of Magna-Rails holds items such as nails, caps, cans, stampings, scrap, finished parts, etc. at fast speeds even up (or down) inclines as steep as 80°. Convey on both top and bottom sides of your lines . . . automatically turn conveyed parts over . . . change direction of flow, etc. Use of steeply inclined conveyor lines shortens belt lines, permits machines to be more closely grouped together. Positive hold prevents items from slipping off the line; improves safety conditions, reduces damaged parts.

Magna-Rail is a 4" wide assembly, standard lengths from 3' to 6', containing a series of Alnico V non-electric magnets. The unit is available in straight or curved sections for direction change of a conveyor line. Magna-Rail will **automatically** convey, control or elevate material from one machine (or operation) to another, with automatic discharge where required. When used with other Eriez HI-POWR magnetic equipment, these units offer unlimited automation advantages.

Lightweight and simple in design, Magna-Rails are easily incorporated into present conveyor lines. No outside power is needed, and maintenance is nil. Magnetic strength is guaranteed indefinitely.

• • • • • • •

Eriez does not design, build or sell material-handling systems, *but we serve people who do* in areas where magnetic equipment should be incorporated. We willingly share the design-and field-application know-how gained through helping others move materials faster, more economically, more efficiently and more accurately by utilizing the inherent advantages of magnetism. Specifically, we produce standard lines of magnetic equipment and, in addition, design and build special components to *magnetically* convey, transfer, control, elevate, re-position, hold or re-orient basic ferrous material or finished parts. As our engineers work very closely with both system manufacturer and ultimate user, the most efficient installation is the end result.

ERIEZ MAGNA-RAIL UNITS PROVIDE THESE IMPORTANT AUTOMATION ADVANTAGES:

• Magnetic strength is guaranteed indefinitely; first cost is the only cost • Completely non-electric; no wires or attachments • Easily incorporated into new or existing equipment • Virtually no maintenance; magnets are trouble-free • Compact size: 4" wide, $1^{15}/_{16}$" high. Standard sizes are 3, 4, 5, 6 ft. (special sizes made to order) • Safe, positive hold • Permits faster conveyor speeds in less space • Lightweight; simple design • Eliminates manual handling, reduces damaged parts • Conveys up inclines as steep as 80° • Many magnetic strengths

Produced under Patent 2, 551,947.

BIG, NEW BULLETIN on magnets for automation.

For your free copy, write:

ERIEZ

Manufacturing Company

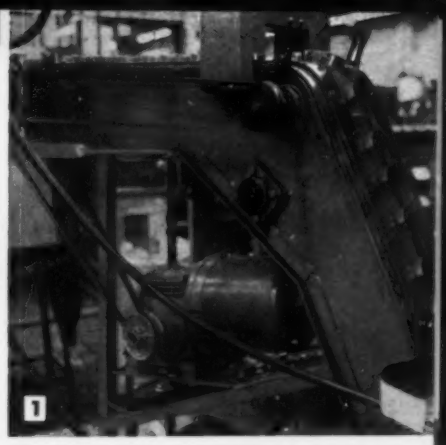
119-J Magnet Drive, Erie, Pa.

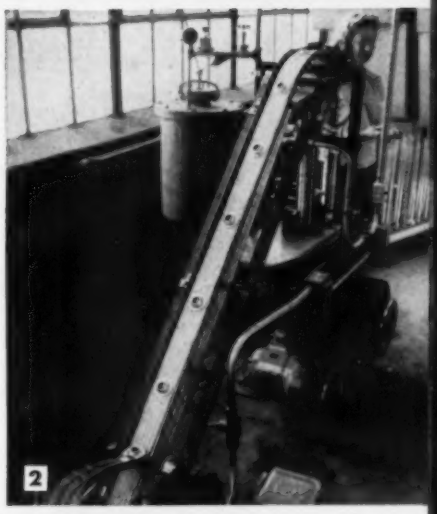
ERIEZ HI-POWR MAGNETS FOR AUTOMATION

PIONEERS AND WORLD'S LARGEST PRODUCERS OF PERMANENT NON-ELECTRIC MAGNETIC EQUIPMENT AND NEW HI-VI ELECTRO PERMANENT MAGNETIC VIBRATORY EQUIPMENT

MAGNA-RAIL SOLVED THESE CONVEYING PROBLEMS:

1. **Cleveland Graphite Bronze Division, Clevite Corp.** Problem: to secure bushings and bearings to a conveyor belt without marring their close tolerances and mirror finish by sudden belt stops or inclines. Solution: MAGNA-RAIL
2. **Sherwin Williams Company.** Problem: to convey paint can tops more quickly without having them slide off the line and to discharge them automatically at the rate of about 100 per minute. Solution: MAGNA-RAIL
3. **R. T. French Company.** Problem: to elevate caps for mustard jars up a steep incline, over a conveyor line, and automatically release them into the hopper of a capping machine. Solution: MAGNA-RAIL
4. **National Can Company.** Problem: to convey can ends at the rate of 200 per minute from a press to a coater, without danger of the ends sliding off the line at this rate of feed. Solution: MAGNA-RAIL





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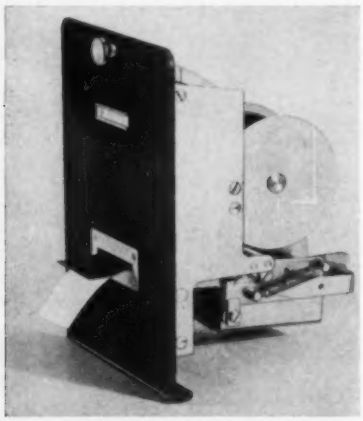
associated with bypass orifices is eliminated. Furthermore, the modified pressure-flow characteristics are obtained only in the frequency region where they are required for improved stability. At low frequencies, the valve functions as a flow control valve to provide characteristically high system stiffness.

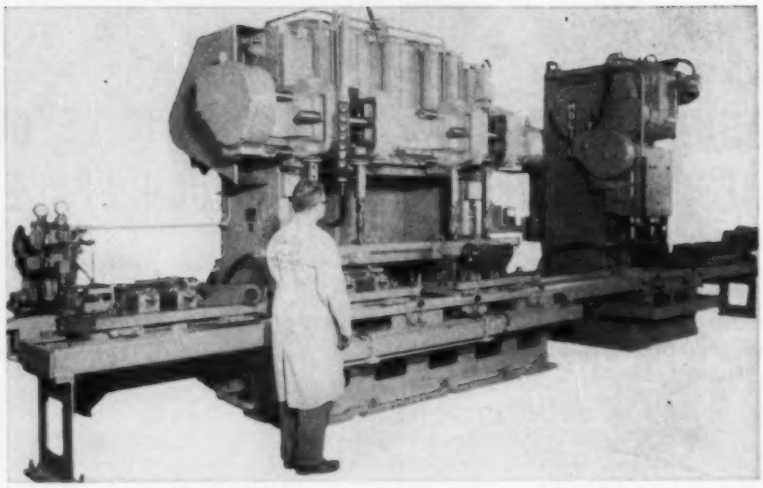
Machine Tool Conference To Stress Electronic Control

TENTH Annual Machine Tool Conference sponsored by the American Institute of Electrical Engineers will be held on October 13-15 at the Statler Hilton Hotel in Hartford, Conn. The conference provides a forum for those wishing to stay abreast of the rapidly changing developments and needs of the machine tool industry.

This year's program presents a balanced coverage of the machine tool industry's progress in the fields of tooling, gaging, machine control, computers, safety, precision positioning, and machine design. Presentations will be made by leading engineers in the industry discussing operating experiences with numerical control, relays and limit switches, and static switching. Other subjects to be covered are tubes versus transistors in machine control, photoelectric line follower control system for flame cutting machines, construction and use of positioning equipment using the principle of magnetostriction, practical problems in applying gages to machines, designing machines for servo drives, and the controlled rectifier and its application.



ELECTRICAL impulse counter that prints on tape is available from Presin Co. Offered in a number of variations, unit may be equipped with up to four 5-digit counting heads which print on one tape that perforates as it issues from the instrument. Printing heads for elapsed time and date are included in the models available. Other large models in production contain as many as 100 five-digit printing heads for recording on a single piece of paper.



HEAVY STEEL LINKS are drilled, core drilled or reamed, and finished bored as they are transferred on platen-type workholding fixtures through three working stations of a combination machine built by Moline Tool Co. The links are drilled from solid steel by the first pair of spindles of the machine on the left. Various sizes of links require drills ranging from 1 to 2½ inches in diameter. The links then transfer on the fixture to a second pair of spindles where the drilled holes are enlarged by core drilling to a maximum diameter of 3⅝ inches. The third station under the two spindles of the machine on the right finish bores the holes for accuracy of hole diameters, parallelism, and surface finish. Each pair of spindles is adjustable to provide from 8 inch to 36 inch center distance between holes.

Westinghouse Develops AC Adjustable-speed Drive

PACKAGED adjustable-speed drive in which an ac motor, a dc motor, and semiconductor rectifiers are integrated into one unit has been announced by Westinghouse Electric Corp. Known as Rectiflow drives, the new units afford continuously variable speed control over speed ranges of 1½ to 1, 2 to 1, or 3 to 1 with a maximum speed of 1690 rpm.

The integrated drive consists of an ac wound-rotor motor and a dc motor built on a common output shaft. Semiconductor rectifiers rectify slip power from the wound rotor to supply direct current to the dc motor armature. A second set of rectifiers is provided to convert ac line voltage to dc to energize the shunt field of the dc motor. Speed control is obtained by varying the shunt field by a rheostat or by electronic and magnetic amplifier equipment.

Presently available in ratings of 7½ to 125 horsepower, the packaged units can be designed to serve either constant-torque or constant-horsepower applications. All power requirements are supplied from normal ac distribution systems. Efficiency of the unit is about 5 per cent less than that of an ac squirrel cage motor, but power factor is essentially the same. Physically, the new units are slightly longer than comparable dc motors but are smaller in diameter.

Special Cigar Machine

UNTIL recently, the popular Bolknak or Club shaped cigar (large fire head, tapering down to the mouth end) could be produced only by skilled hand manufacture. The art of making cigars manually is rapidly becoming a rarity because of the necessarily long apprenticeship, and for sometime it was feared that the Bolknak would be lost to smokers completely. Arenco AB, Stockholm, has designed a means whereby the

Circle 661 on Page 161→

U. S. Steel Uses Load-O-Matic for Heavy-Duty Scrap-Salvaging Operation

Westinghouse Load-O-Matic hoist control panel for this 125-hp, 25-cycle installation.

Hoisting a heavy roll-end hour after hour for crushing open-hearth slag during scrap-salvaging operation is rugged duty for any crane—and on this 60-ton Alliance crane Westinghouse Load-O-Matic* assures long, dependable operation at the United States Steel Corporation's Ohio Works.

Because Load-O-Matic is a heavy-duty, yet precision a-c crane system built to industry standards, it is highly favored for applications that call for unusual stamina, ease of operation and low-maintenance cost.

The Load-O-Matic system with stepless speed control over the full load range eliminates initial cost and complexity of d-c conversion equipment. Components, including controls, motors, brakes and gearing, are Westinghouse Power-Up products, built to work together and backed by Westinghouse unit responsibility.

To see Load-O-Matic in operation, call your local Westinghouse salesman. For more information, write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pa. JI-96124

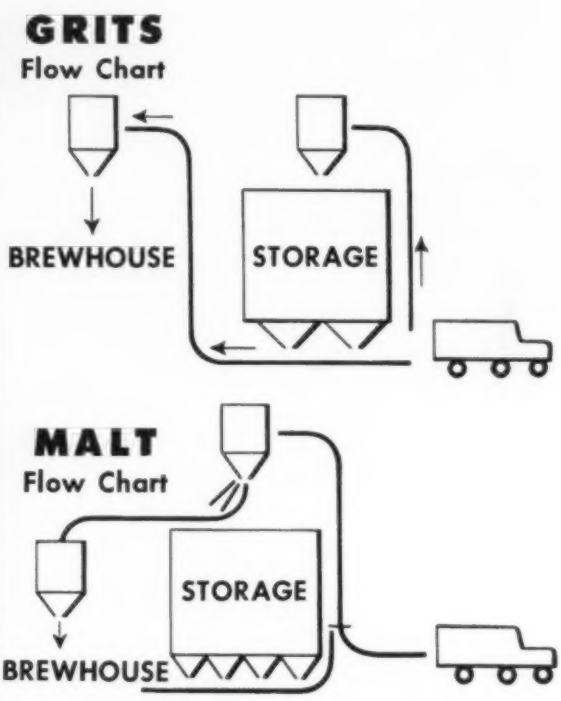
*Trade-Mark

YOU CAN BE SURE...IF IT'S

Westinghouse

The Arithmetic of Materials Handling

FULLER AIRVEYOR pneumatic system pulls corn grits from discharge of Airveyor bulk transport trailer to storage silos to weigh hoppers.



PIELS MODERNIZES WITH AIRVEYOR®

saves man-hours, materials, money

When Piel Bros., Brooklyn, N. Y., took over the Staten Island plant of another brewery, they replaced complicated, inefficient mechanical conveyors with a fast, efficient Fuller pneumatic Airveyor® system—to handle tons of malt and corn grits.

Here's what the new Fuller Airveyor system has accomplished:

ELIMINATION OF POSSIBLE CONTAMINATION in the old mechanical system. Totally-enclosed Fuller Airveyors prevent material loss through spillage and eliminate the problem of possible infestation. 100% visible dust retention contributes to sanitary working conditions.

MAJOR LABOR-SAVING through fully automatic control of Airveyors. One man —at pushbutton panel—handles unloading of Airveyor bulk transport trailers, conveying to silos, and directs weighing and proportioning operations.

NEGLIGIBLE MAINTENANCE, because Airveyors have few moving parts and are self cleaning! Downtime for cleaning mechanical equipment previously required eight man hours a week.

If you are now handling dry, granular materials, it will pay you to look into Fuller pneumatic conveying systems. Fuller systems are engineered specifically for your particular application. They bend around corners, run up or down, through walls and floors, almost any distance — even underground. Write or phone today outlining your problem. Fuller will gladly furnish additional information with appropriate recommendations.

THE ULTIMATE in automation — Fuller Airveyor offers simplified, precision control from this remote control "pushbutton" panel.

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A-262
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Circle 679 on Page 161

HEAVY DUTY PLANER manufactured by G. A. Gray Co. has no idle return stroke and cuts metal both ways. Standard carbide tips are used in simple double cutting tools. The double cutting technique can be combined with a third single cutting action to obtain triple cutting, providing rough and semifinish planing at the same time.

Bolknak shape can be accomplished mechanically and, with experimental work on the machine completed, the company has recently announced its availability to manufacturers.

Diminutive Snap Action Switch

SUB-SUBMINIATURE snap action switch has been introduced by Micro Switch, Div. of Minneapolis-Honeywell Regulator Co. The single-pole double-throw switch measures 0.5 x 0.35 x 0.2 inch (on the case) and is rated for 5 amps at 250 v ac and 30 v dc. Ten of the switches can be mounted in an area of one square inch.

The case, cover, and plunger of the new switch are made of high strength plastic. Contacts are of fine silver, and unique snap-action spring is fabricated from beryllium copper. Operating force is 6 oz maximum, release force is 1 oz minimum. Details are not given, but the company states that the switch represents a new design concept.

Plastic-Metal Laminate Unaffected By Fabrication

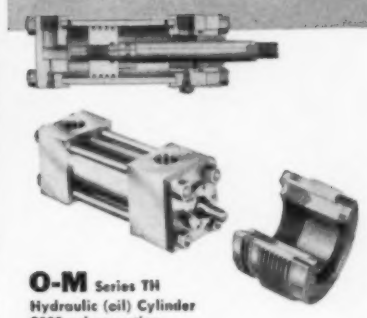
VINYL-TO-METAL laminate has been introduced by American Nickeloid Co., manufacturer of prefinished metals. The new material consists of solid vinyl film fused by extreme heat and pressure to chemically treated steel or aluminum. Thus it combines the strength, rigidity, and impact resistance of metal with the beauty, color, and texture of vinyl.

The product's color and surface embossing are very stable and the material is highly resistant to abrasion, impact, and staining. The vinyl does not affect the basic fabricating properties of the base metal. It may be deep drawn, bent, punched, roll formed, crimped, etc., with standard production techniques without separation of the laminate or damage to the surface. It is expected to find application for such products as television and radio cabinets, luggage, furniture, appliances, store fixtures, and business machine housings.

SPOTLIGHTING PEOPLE

James L. Wheeler appointed general manager of Die Div., Clearing Machine Corp. . . . **George M. Muschamp** appointed vice president-engineering of the Industrial Products Group and **John M. Wilson** named director of engineering of the Brown Instruments Div., Minneapolis - Honeywell Regulator Co. . . . **C. M. Lewis** appointed manager, Systems Marketing, Industrial Electronic Products, Radio Corp. of America . . . **R. C. Wilson**

DESIGNED FOR HEAVY DUTY BUILT TO TAKE IT!



O-M Series TH
Hydraulic (oil) Cylinder
2000 psi operation
3000 psi Non-Shock
available in 1½ to 8" bores
Meets JIC Standards

Every engineering and construction detail of the improved O-M Tie-rod Hydraulic Cylinder adds to its overall operating efficiency under heavy work loads, assuring maximum smooth performance with minimum maintenance. It is ruggedly constructed of heavy walled, seamless steel tubing microhoned to minimize friction. The rolled steel heads are recessed to confine the tube, prevent breathing and to provide additional protection against leakage under the most severe conditions. Heads can be rotated independently at 90° intervals for convenient port location. The piston rod is of stress relieved, high tensile steel, hard chrome plated turned, ground and polished. The rod gland cartridge that is threaded for quick, easy removal, is accurately piloted in rod head to assure perfect alignment, also serves as pilot for cylinder mounted on rod end. Rod gland contains extra long bronze rod bearing for maximum support of piston rod.

Vee type, non adjustable, self compensating, rod gland packing provides multiple lip seal. Cartridge "O" ring, with leather back up furnishes a positive seal. Rod wiper or interchangeable metallic scraper prevent dirt from entering cylinder on "in" stroke. A complete selection of mounts is available.

These and many other features are described in detail in our latest catalog No. 105. Write for your copy TODAY or consult your local O-M representative.

ORTMAN-MILLER MACHINE CO
25 143rd Street, Hammond, Indiana
☐ Have representative call
☐ Send Bulletin 105

Name_____ Position_____
Company_____
Address_____
City_____ Zone_____ State_____

Circle 662 on Page 161

RIVETING REVOLUTIONIZED by the PAR PROCESS!

PAR ... **Originated by TRS** with the invaluable collaboration of some of industry's top production engineers who sought a major break-through in the automation of assembly operations to reduce costs.

PAR ... **A name given by TRS to its Production Automated Riveting process** . . . continuously developed and perfected for 3 years. Proved successful in some of industry's most efficient plants. Now, TRS has sufficient engineers especially trained in the PAR process to serve all manufacturers.

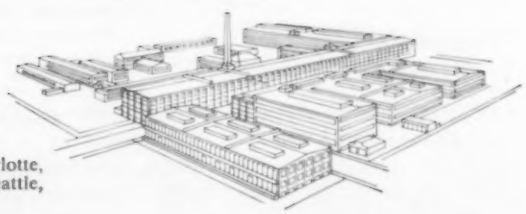
PAR ... **It makes riveting practically a new fastening method through efficiently integrated and automatic . . .**

1. FEEDING of tubular rivets or related products.
2. TRANSFER of parts between riveter stations by means of sliding or rotating fixtures or dial tables. Or through synchronization with conveyors.
3. SEQUENCING the operation of from 3 to 15 rivet setters which make all fastenings simultaneously or in any desired sequence.
4. CONTROL of setting force as required by parts thickness or material characteristics.
5. SENSING of improper conditions and stopping equipment to avoid injury to parts, equipment or operator.
6. EJECTION of parts as required.

TRS®

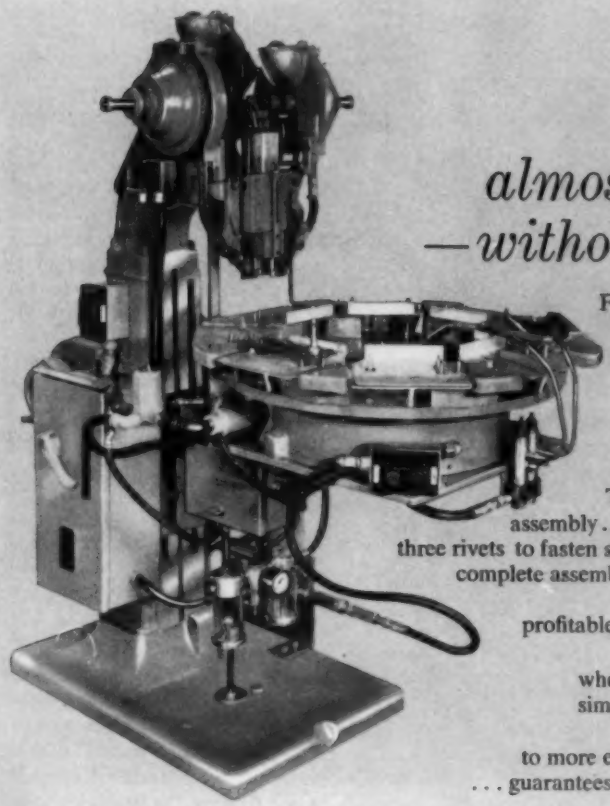
TUBULAR RIVET & STUD COMPANY

QUINCY 70, MASS.



See us at the **NATIONAL METALS EXPOSITION**

Midwest Office & Warehouse in Chicago. *Branches:* Atlanta, Buffalo, Charlotte, Dallas, Detroit, Indianapolis, Los Angeles, New York City, Philadelphia, Seattle, St. Louis. *See "Yellow Pages" for phone numbers.*



FORD

almost tripled production —without adding to payroll

Ford engineers wanted to step-up the production rate on a window gear and cam assembly. They called in TRS engineers.

Here is the remarkable automatic TRS Machine that resulted. Because center distances would not permit employment of a Multi-Head Riveter, a triple drive machine was adapted by TRS engineers. This eight dial station set-up receives a gear and cam assembly . . . greases it . . . receives a shaft and housing . . . sets three rivets to fasten shaft and housing to the gear and cam unit . . . ejects complete assembly. The machine does everything but load the parts. Ford Motor Company know-how shows in the profitable solution . . . so does TRS ingenuity and experience.

You get the benefit of TRS "recognized ability" when you buy any TRS Riveting Machine . . . from the simplest, standard type to a complicated special design.

TRS offers more machines, to more exactly meet your need . . . will lease but likes to sell . . . guarantees performance and sticks by you with all-out service.

PAR . . . It's a TRS Process for very good reasons!

Obviously, there are two critical elements in the PAR Process. Essential is the special and extensive knowledge and experience needed to design an integrated system of standard or multi-head riveters, feeders, transfers and controls for the particular assembly involved. Equally important are superior knowledge and experience in the design, tooling and application of Multi-Head Riveters because these are usually employed.

TRS originated Multi-Head Riveters over three years ago and is the only experienced source of these machines. Further, because this TRS development opened up new possibilities for automating the riveting process, TRS was able to begin three years ago to develop the special experience and application engineers required to fully meet the requirements of the PAR Process.

PAR . . . A New Opportunity to Reduce Direct Labor Charges

With this new help, hundreds of manufacturers . . . large and small . . . can effect substantial savings in direct labor charges, increase production rates, decrease parts spoilage and machine down-time. Look into it now if your product can be riveted, and especially if several rivets are involved.

The yearly amortized cost of the TRS Multi-Head Riveter equipment is low because it will not be obsoleted by changes in product design or production line.

To save more . . . To protect against equipment obsolesence . . . don't buy any Riveting Machines until you investigate the PAR Process

You're not required to use TRS Rivets but you'll be better off if you do

There are no contracts or obligations involved in the PAR Process. However, it is true that the more automatic you make your riveting, the more important it is to use rivets that reduce operating troubles and machine down-time. And, we can give you good, factual reasons why TRS Tubular Rivets are more reliable in essential qualities and uniformity. Ask for the facts . . . judge for yourself.

Advt. Copyright by Tubular Rivet & Stud Company, 1958

NEW in Data Recording

MONROE

DATA/LOG

NEW

...**PRINCIPLE.** Parallel entry DATA/LOG printers with automatically positioned carriages.

...**FORMATS** for printed copy.

...**CARRIAGES.** Programmable carriages accept narrow or wide forms up to 18 inches, with front feed carriages for card insertion.

...**CAPACITIES.** From three to 14 digits for each print cycle.

...**ACCUMULATORS.** Up to 4 accumulators with 14 digits each.

...**FACILITY.** Each DATA/LOG has its own control chassis, power supply, control relays, and timing pulses.

DATA/LOG PRINTERS INCLUDE:

Series MC 202, 13" or 4¾" fixed position carriage, with or without accumulators. Readout Speed up to 180 print cycles per minute.

Series MC 203 & 204 each provides up to 14 digits maximum, on an 18½" or 15¾" programmable tabulating carriage. Up to 150 print cycles per min.

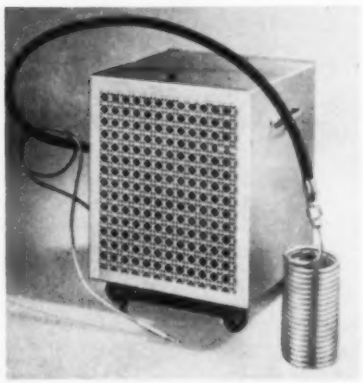
Series 203 comes *without* accumulators, Series 204 is available *with* up to 4 accumulators of 14 digits each.

Series MC 205, provides 5, 6, 7 or 8 bit punched tape, with any coding for computer input. The basic printer provides up to 10 digits printout on a 13" or 4¾" fixed carriage, with or without accumulators. Two accumulators have 2 to 10 digits maximum each. 64 cycles per minute can be punched, and 140 cycles per minute printed.

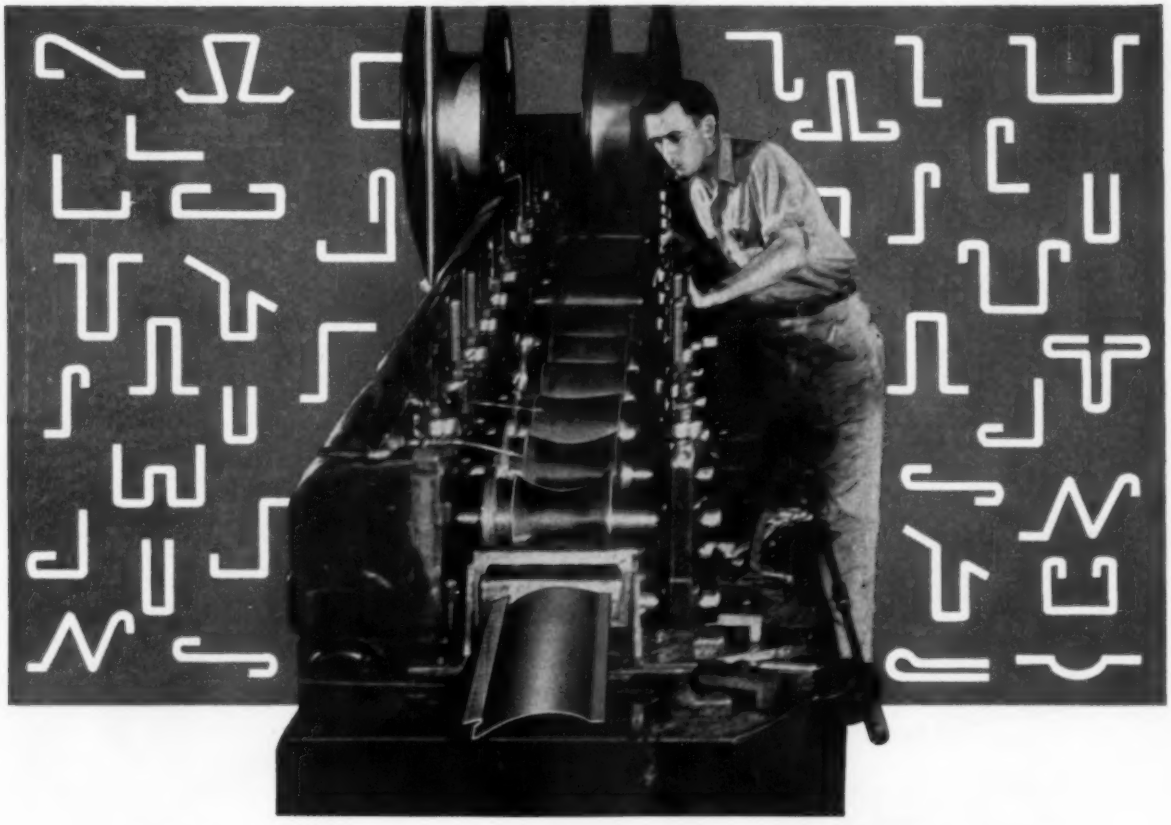
MONROE DATA LOG

Write to:
MONROE Calculating Machine Company, Inc.
Electronics Components Division
60 Main Street, San Francisco, Calif.

named manager-manufacturing and plant operations, Distribution Assemblies Dept., General Electric Co. . . . **William I. Wilt** appointed vice president of the Gage and Instruments Div., Sheffield Corp. . . . **Dr. Clark A. Dunn** elected president of the National Society of Professional Engineers. He is a professor of civil engineering and executive director of the office of Engineering Research at Oklahoma State University . . . **McLain B. Smith,** assistant general manager of the Data Processing Div., elected vice president of International Business Machines Corp. . . . **W. A. Rote** named director of engineering for the Boston Div., Minneapolis-Honeywell Regulator Co. . . . **John A. Marsh** elected president of the National Fluid Power Association. He is vice president in charge of sales, Air and Hydraulics Div., Rivett Lathe & Grinder Inc. . . . **William F. Crawford** named president of Republic Flow Meters Co. . . . **A. N. Kaiser** appointed chief engineer of the Syracuse Div., Electric Auto-Lite Co. . . . **Jay L. Fisher** named production manager for the Federal Instruments Group, Industrial Products Div., International Telephone and Telegraph Corp. . . . **Jack I. Stahl** joined Servo Corp. of America as production manager of the manufacturing division . . . **Everett J. Long** appointed director of the



REFRIGERATED cooling coil which can be immersed in liquid or placed in a cabinet to create a cold chamber is available from Andrew Technical Supply Co. The portable unit comprises a rolling cabinet housing a compressor and a thermostat, a cooling coil on a 5-foot extension hose, and a temperature probe. Thermostatic control maintains temperatures within 2F of setting from ambient to 5F. Operating on 115v ac, the unit is also available with special coils for corrosive conditions.



With a Yoder...ONE MAN PRODUCES 30,000 FEET OF SHAPES A DAY!

Cold-roll forming with a Yoder Roll-Forming machine makes spectacular production possible in many metalworking applications and industries.

A multitude of shapes, simple or complex, produced from a wide variety of coated or uncoated stock, and destined for a virtually endless list of purposes, can be easily, quickly and economically produced with a Yoder cold-roll forming machine.

Whether it be moldings, structurals, siding, roofing, tubulars, cabinet shells, or any one of a thousand requirements, it can be quickly produced with accuracy and uniformity the Yoder way. The conversion cost is usually so low that even part-time operation makes a Yoder cold-roll forming line a profitable investment.

A great many modifications of the basic shape such as welding, coiling, ring forming, notching, perforating, embossing and cutting to length, can be simultaneously introduced with little or no additional labor cost. It will pay you big dividends to fully investigate the advantages of Yoder cold-roll forming. A fully-illustrated, 88-page book clearly discusses every important aspect of this amazingly versatile method of metal fabrication... it is yours for the asking.

THE YODER COMPANY
5526 Walworth Ave. • Cleveland 2, Ohio

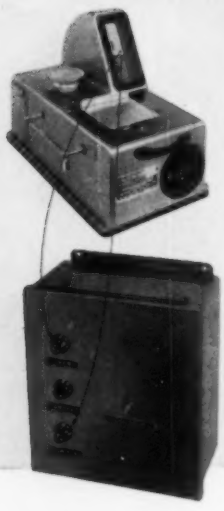
ENGINEERING **YODER** MANUFACTURING

COLD ROLL FORMING MACHINES
PIPE AND TUBE MILLS (ferrous or non-ferrous)
ROTARY SLITTING LINES

Circle 665 on Page 161

BASIC WEIGHT CLASSIFIER

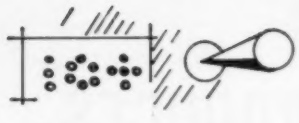
...new aid for controlling your quality and costs



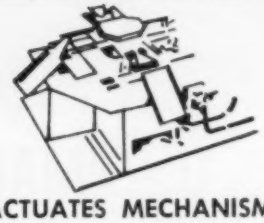
CHECKWEIGHS
products
packages and
assemblies

CLASSIFIES
by weight

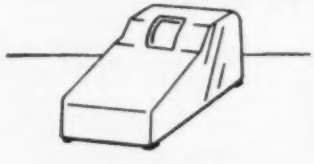
. . . and through electronic controls, performs these and many other remote functions!



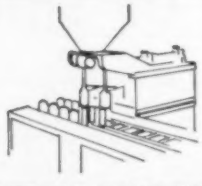
OPERATES SIGNALS



ACTUATES MECHANISMS



RECORDS DATA



CONTROLS PROCESSING

Now you can checkweigh or classify items by weight and utilize the data wherever you need it — and in the form that best fits your needs. The Basic Weight Classifier, employing Shadograph Scale with photocell controls, provides electronic signals which indicate correct weight, or over or under within pre-set limits. Any number of classifications from 2 to 128 may be used. Units are available to handle items in any shape in a capacity range from 2,000 milligrams to 100 lbs. Write for Bulletins 3333 and 3347.

Exact Weight SCALES

THE EXACT WEIGHT SCALE CO.
907 W. FIFTH AVE., COLUMBUS 8, OHIO
In Canada P.O. Box 179, Station S, Toronto 18, Ont.

Sales and Service Coast to Coast

Find us in your local 'Yellow Pages'

BETTER QUALITY CONTROL . . . BETTER COST CONTROL

Circle 666 on Page 161

Transducer Div., Consolidated Electrodynamics Corp. . . . **John F. Daly** appointed production manager of Endevco Corp. . . . **Robert J. Ehret** appointed staff engineer assigned to product development in the Instrumentation Div., Ampex Corp. . . . **William P. Munger** elected president of the research and development firm of Hydel Inc. . . . **Donald Z. Erle** named chief engineer on fluid control devices by Hydrodyne Corp. . . . **Paul Dulong** appointed manager of Engineering Services Dept., Epsco Inc.

ELECTRONIC indicator tube for the visual display of numerals at viewing distances of over 150 feet has been developed by Electronic Tube Div., Burroughs Corp. The 3-inch diameter tube contains a stacked array of numerals from zero to nine. Desired numeral is illuminated with a neon glow by applying voltage between it and a common anode. Miniature indicator tube of similar construction is shown at the right.

SPOTLIGHTING PRODUCTS

Photoelectric floodlight control is available from Roth Mfg. Co. to automatically turn on and off light systems at dusk and dawn. One unit can control 2000 watts of fluorescent or neon lights, or 1000 watts of incandescent lights. By using a power contactor, unit can control a bank of lights with an unlimited load. Photoelectric cell can be adjusted to respond to light levels between ½ to 100 foot-candles. . . . *Air bleed-off valve* for use in hydraulic circuits under pressures up to 5000 psi is available from Denison Engineering Div., American Brake Shoe Co. Valve is installed in pump discharge line, ahead of all other components, with a T-connection. As long as system

DYNAMATIC®

Drive Package Provides Infinitely Adjustable Speeds from AC Power Source

CONTROL PANEL

CONTROL STATION

The complete Dynamatic power package includes all components required to provide infinitely adjustable speeds from an alternating current power source. A Dynamatic Ajusto-Spede® or Dynaspede® Drive, with electronic control and pushbutton station, satisfies the requirements of almost any application where proper machine operation or material processing depends upon control of operating speeds.

The compact control panel may be remotely mounted to conserve valuable space on the driven machine. The pushbutton station at the operator's position puts vital controls conveniently at the operator's fingertips and requires a minimum of space.

Speeds are infinitely adjustable from 0 RPM to full output speed, and accurate speed regulation may be obtained from 100 RPM to full output speed.

Ajusto-Spede® Drives, available in ratings of ¼ horsepower to 75 horsepower, are air-cooled. Dynaspede® Drives, rated from 3 to 75 horsepower, are liquid-cooled. Raise your productive efficiency with Dynamatic eddy-current units.

DYNAMATIC®
AJUSTO-SPEDE DRIVE

Send for Illustrated Literature Describing Dynamatic Adjustable Speed Drives

EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

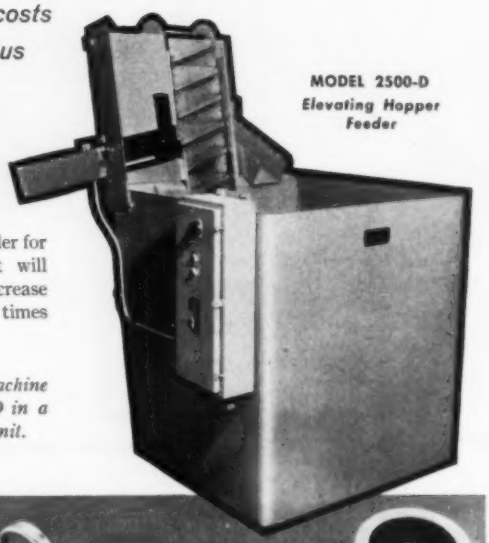
Circle 667 on Page 161

how to feed bearings faster

WITH AN AUTOMATIC

Feedall

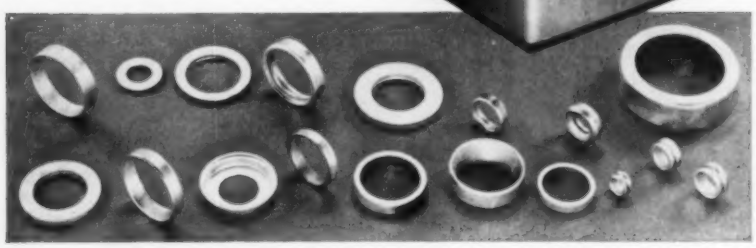
and save time, cut costs by eliminating tedious hand operations



MODEL 2500-D
Elevating Hopper Feeder

PROBLEM: Design a feeder for high-speed machines that will eliminate hand feed and increase bearing output at least 3 times normal rate.

SOLUTION: *Combine machine with Feedall Model 2500-D in a fully integrated automatic unit.*



Bearing manufacturers are finding the installation of Feedall machines a quick and profitable way to obtain faster, better, lower-cost production.

Model 2500-D (above) does the job . . . eliminating hand-feed on double-disc grinders, heat-treat machines and special equipment. It features an 18 cu. ft. hopper load, elevates and orients the bearings, feeds them at selectable speed with multi-million cycle reliability. The "complete-package" feeder installs easily, forms a self-contained unit for automatic production from extrusion to final processing and assembly or delivery.

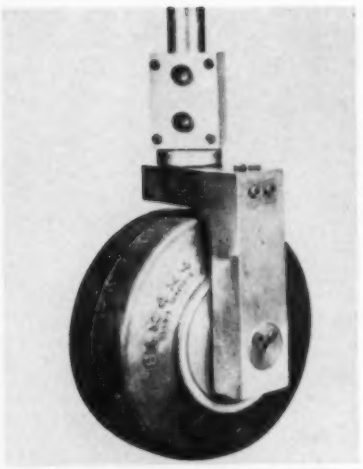
Useful features include: electronic controls for any desired timing sequence; adjustable take-off height and elevating angle; simple adaptation to special requirements; and rugged construction for continuous, heavy-duty service.

Interesting details to help *your* bearing production move faster at lower cost are available in new catalog, "Increased Production." Send for your copy today . . . or send us brief data and sample parts. We'll do the rest, promptly.

Feedall — *Producers of automatic feeding devices*
FEEDALL, INC., WILLOUGHBY, OHIO

ELEVATING, BLADE, TUMBLE, VIBRATORY FEEDERS • TRANSFER AND ELEVATING CONVEYORS • SPECIAL SELECTOR DEVICES

Circle 668 on Page 161



HYDRAULICALLY-OPERATED drive wheel developed by Mechanisms Co. is designed to propel any platform lift unit of 1000 to 2000 pounds capacity that uses an electrically driven hydraulic pump for lifting the load. Swivel block of the device bolts onto the lift unit, and oil lines are connected to two ports in block. Unit may be steered through 360 degrees and will attain a maximum speed of 2mph when connected to a pump rated at 1gpm at 1000 psi.

pressures remain low, valve remains open to permit air to flow from pump to tank. When air has been dissipated, the initial surge of hydraulic fluid automatically closes valve until pressure drops again. . . . *Self-insulating fasteners* having plastic heads and metal bodies are offered by Gries Reproducer Corp. Available in a variety of colors, plastic heads can be applied to many types of ferrous and nonferrous fasteners such as machine screws, wood screws, studs, rivets, and nails. In addition to electrical insulating properties provided by plastic head, fasteners furnish effective sealing, withstand impact, have good thermal insulating properties, and prevent marring of surface finishes when tightened. . . . *Nickel coated titanium wire* is available from Little Falls Alloys Inc. for use as a material for ceramic to metal brazing. The wire will melt to bond with ceramic and is composed of 71½ per cent titanium and 28½ per cent nickel. It is available in sizes from 0.004 to 0.062 inch.

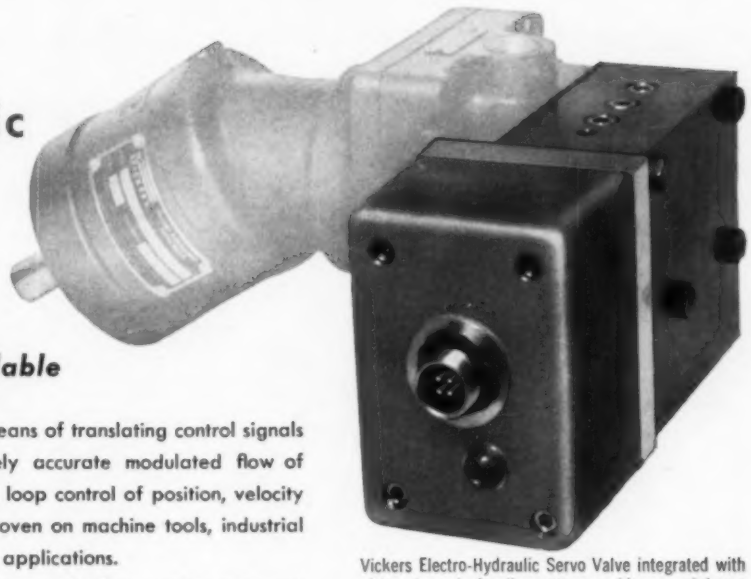
SPOTLIGHTING PLANTS

Genesys Corp., subsidiary of Chance Vought Aircraft Inc., has entered into the field of industrial process

New VICKERS® Electro-Hydraulic Servo Valve

has numerous advantages for industrial use:

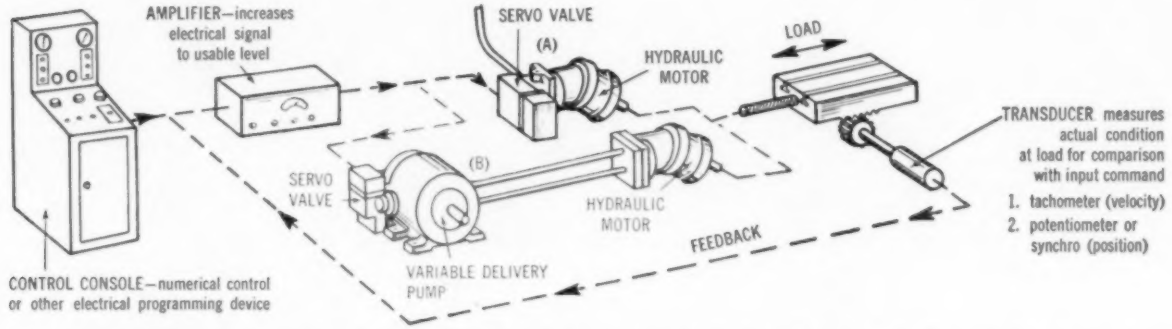
- ***Extremely Accurate***
- ***Simple • Rugged • Dependable***



This valve provides a simple, dependable means of translating control signals from electronic programming into extremely accurate modulated flow of hydraulic power for fast and precise closed loop control of position, velocity and acceleration. Performance has been proven on machine tools, industrial processing equipment and ground ordnance applications.

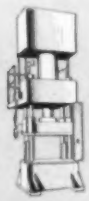
Simplicity and reliability are exceptional . . . only four moving parts are required. Mechanical feedback linkage with unique variable fulcrum provides optimum flexibility for various conditions of flow, response and pressure. For further information, write for Vickers Engineering Bulletin 58-74.

Vickers Electro-Hydraulic Servo Valve integrated with piston type hydraulic motor provides a minimum amount of oil under compression. Integral cross line relief valves are provided as well as variable cross line orifice for controlling viscous damping. This "package" can provide approximately 20 hp @ 3000 psi and 3600 rpm; variable speed of motor is 0-4400 rpm.



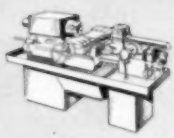
Now the flexibility of electronic control can easily be applied to versatile hydraulic power. Vickers new industrial electro-hydraulic servo valve is used (A) to directly regulate the oil to an actuator (valve motor system). Shown in blue is an alternate application (B) for higher flows when the valve controls a variable volume pump (servo pump system).

REPRESENTATIVE SERVO VALVE APPLICATIONS

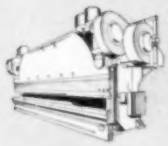


PRESS
Ram velocity controlled accurately during all cycles.

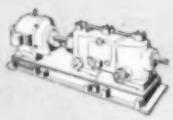
MILLING MACHINE
Precision control of velocity, position and acceleration of slides and tables.



LATHE
Exact feed rate and position control of cutting tool.



PRESS BRAKE
Cylinders synchronized precisely.



VARIABLE SPEED DRIVE
Accurate velocity control of spindle speeds for test stands or machine tools.

PROCESS LINE
Programmed control of Material Handling and machine sequencing.

8126

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1536 • Detroit 32, Michigan

Application Engineering Offices: ATLANTA • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • GRAND RAPIDS • HOUSTON • INDIANAPOLIS • LOS ANGELES AREA (El Segundo) • MILWAUKEE • MINNEAPOLIS • NEW YORK AREA (Springfield, N.J.) • PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) • PORTLAND, ORE. • ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS • TULSA • WORCESTER • Factories also in: AUSTRALIA, ENGLAND, JAPAN AND GERMANY • In Canada: Vickers-Sperry of Canada, Ltd., Toronto, Montreal and Vancouver

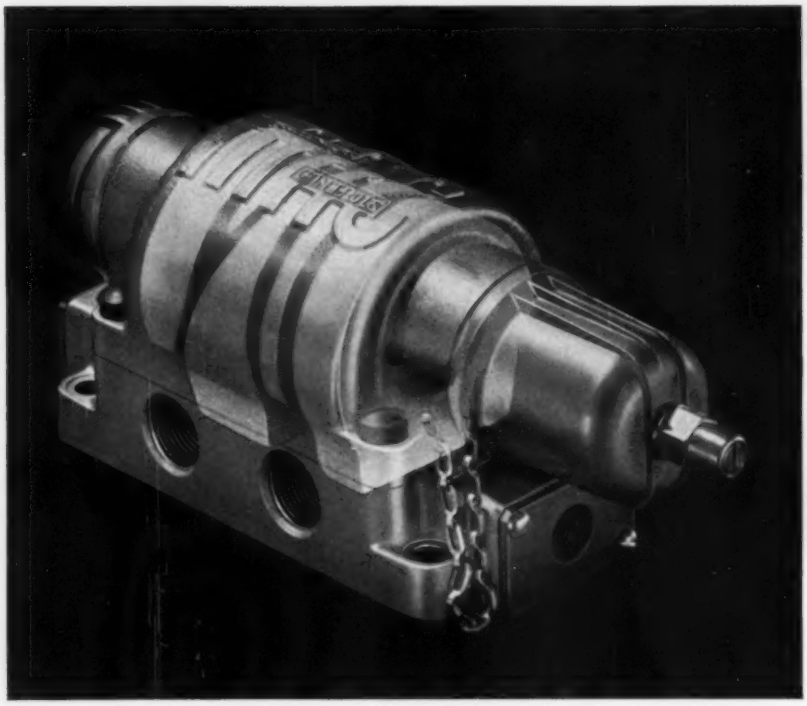
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Circle 669 on Page 161

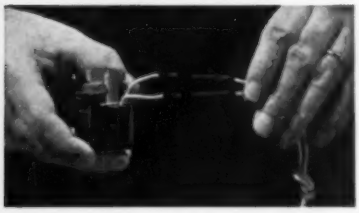
Introducing the revolutionary new MAC 4-way

DUAL-SPOOL

CIRCULAR-FLOW AIR VALVE



The MACsolenoid energizes the inner spool, releasing compressed air to activate the outer spool. There is no lag between spools. The shock load of the main spool is dissipated through rubber cushions.



The Dual-Spool's proved MACsolenoid has new instant plug-in wire lead connectors that are waterproof and vibration-proof. The solenoid and cover assembly detach in seconds without tools.

Features efficient spool-within-a-spool design...sells for about half the price of most other ½" to 1¼" valves... meets all J.I.C. specifications

MAC's new Dual-Spool air valves represent an entirely new principle in air valve design. They operate at speeds that meet any known requirement . . . with shorter stroke . . . direct operation . . . and a highly efficient *circular* air flow that provides full flow throughout rated capacities.

They operate on the *low current requirements of minimum amplified circuits* . . . needing just .8 amperes of inrush current and .125 amperes holding at 115 volts—60 cycles. The new Dual-Spool valves are compact, too . . . about one half the size of similar-use competitive valves (½" to 1¼") . . . and sell at about half the price in single- and double-solenoid models.

Fewer parts and simple design reduce maintenance. Integral conduit boxes connected by wiring channels permit optional wiring. Plug-in wire lead connectors speed up installation. The MACsolenoid—which operates up to 30 *million cycles* without appreciable wear—shaves replacement costs to a minimum.

4-way Dual-Spool air valves are now available in ½", ¾", 1" and 1¼" pipe sizes . . . are fully tested and guaranteed. Contact a MAC representative listed at the right or write direct for complete details.

Pat. applied for on all valve features ©MAC

MECHANICAL AIR CONTROLS, INC. MAC 10030 Capital, Oak Park, Detroit 37, Michigan

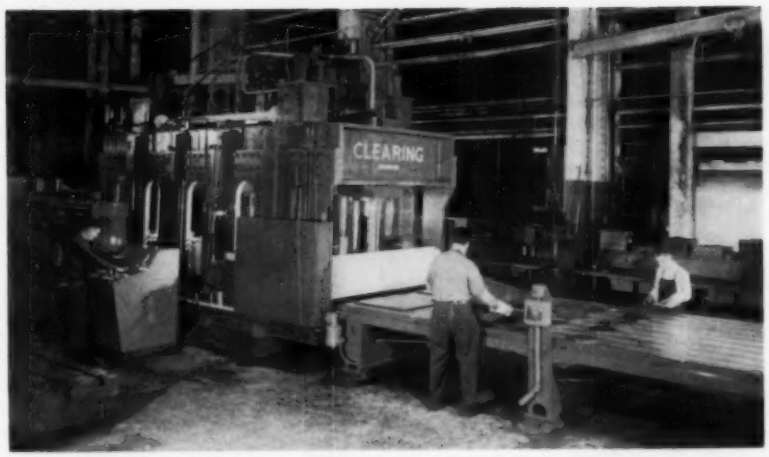
Circle 670 on Page 161

PHONE YOUR NEARBY "MAC" REPRESENTATIVE FOR DATA AND DELIVERY

ALABAMA
BIRMINGHAM 5—T. Ed Kinard, 1013 S. 21st Place, ALpine 2-7912
ARKANSAS
Branch-Merwin Tool Specialists, 477 N. Bellevue, Memphis 5, Tenn., BRoadway 8-6102
CALIFORNIA
OAKLAND 8—The Rucker Co., 4700 San Pablo Ave., OLympic 3-5221
SOUTH GATE—The Rucker Co., 4956 Firestone Blvd., LOrain 4-2521
FLORIDA
MIAMI SPRINGS—Aero Hardware & Supply Inc., 4301 Northwest 36th St., TUxedo 8-2414
GEORGIA
SMYRNA—E. Warren Althouse, 204 Benson Ave., HEmlock 5-0143
ILLINOIS AND IOWA
CHICAGO 6—Walter Norris Engineering Co., Civic Opera Bldg., 20 N. Wacker Dr., STate 2-2804
(**SOUTHERN ILL.**) Oscar E. Jost Co., P.O. Box 6, St. Ann, Mo., HArrison 8-4488
INDIANA
EVANSVILLE 14—Neff Engineering Co., 2509 Washington Ave., GReenleaf 7-4141
FORT WAYNE 3—Neff Engineering Co., Station A, P.O. Box 2001, 2339 Crescent Ave., EAstbrook 7391
INDIANAPOLIS 2—Neff Engineering Co., 1955 Central Ave., WAlnut 5-5311
SOUTH BEND—Neff Engineering Co., 707 South Eddy St., ATlantic 7-5655
MARYLAND (and Dist. of Columbia)
BALTIMORE 18—N. B. Cochrane Co., 100 E. 20th St., HOpkins 7-4884
MASSACHUSETTS (and New England)
BOSTON 34—Electrical Apparatus Co., Inc., 1200 Soldiers Field Rd., STadium 2-7440
MICHIGAN
BAY CITY—Fred Kober, 506 So. Chilson St., TWinbrook 2-2629
FLINT 2—Kober Sales Engineering Co., 1115 Root St., CEdar 2-7165
WESTERN MICHIGAN—Everett Adams, 17212 Sharon Road, Chesaning, Michigan, VIctor 5-3446
MINNESOTA
MINNEAPOLIS 9—Air & Hydraulic Equipment Co., 15 E. 38th St., TAylor 3-6118
MISSISSIPPI
Branch-Merwin Tool Specialists, 477 N. Bellevue, Memphis 5, Tenn., BRoadway 8-6102
MISSOURI
ST. LOUIS COUNTY—Oscar E. Jost Co., P.O. Box 6, St. Ann, HArrison 8-4488
NEW JERSEY
(**NORTHERN**) Machinery & Machine Supplies Co., Inc., 305 East 47th St., New York 17, New York, PLaza 8-0744
(**SOUTHERN**) Automation Aides, 1618 Willow Ave., Philadelphia 26, LaMott, Pennsylvania, MElrose 5-5555
NEW YORK
BUFFALO 25—C. H. Tepas Co., 137 Lamarck Drive, Circle 3210
NEW YORK 17—Machinery & Machine Supplies Co., Inc., 305 East 47th Street, PLaza 8-0744
OHIO
CINCINNATI 2—Fluid Power Engineering Co., 205 Keith Bldg., MAin 1-6640
CLEVELAND 9 (PARMA)—Fluid Power Engineering Co., 5451 Broadview Rd., FLorida 1-1199
OREGON
PORTLAND—The Rucker Co., 1633 N. W. 21st Ave., CApitol 3-0205
PENNSYLVANIA
PHILADELPHIA 26, LaMOTT—Automation Aides, 1618 Willow Ave., MElrose 5-5555
PITTSBURGH—Machinery & Machine Supplies Co., Inc., 1307 Rutherford St., LEhigh 1-1235
TENNESSEE
MEMPHIS 5—Branch-Merwin Tool Specialists, 477 N. Bellevue, BRoadway 8-6102
TEXAS
DALLAS 35—Womack Machine Supply Co., 2010 Shea Road, FLeetwood 7-3871
HOUSTON 2—The Wendler Co., 357 M & M Building, CApitol 4-2200
WASHINGTON
SEATTLE—The Rucker Co., 1000 4th Ave., South, MAin 2783
WISCONSIN
MILWAUKEE 17—Neff Engineering Co., 5856 No. Pt. Washington Rd., EDgewood 2-1579
CANADA
MONTREAL—L. S. Tarshis & Sons, Ltd., 450 McGill St., Quebec, PLateau 2963
TORONTO—Trevor Babbs, National Time & Signal Co., 72 Shilton Rd., Agincourt, Ontario, OXford 1-4857

MECHANICAL AIR CONTROLS, INC.
DETROIT 37, MICHIGAN
MAC

Circle 670 on Page 161



HYDRAULIC metal-bonding press built by Clearing Machine Corp. helps to lower production costs at Convair (San Diego), Div., General Dynamics Corp. Press is used for bonding together thin gage metal parts which have been preblanked into the desired shape and size. Laminated assemblies are set up on an aluminum tool plate outside of the press. When loaded, plate is powered into press over a series of rollers. Inside the press the rollers are lowered, setting the tool plate onto a hot plate built into the press bed. The press slide, equipped with a similar hot plate, moves down onto the assemblies and dwells for a predetermined time. After automatic retraction of the slide, the tool plate and the bonded assemblies are removed, and a similar tool plate, which has been loaded on the opposite end of the press, moves into position in the press.

control and will manufacture and develop commercial digital control computer systems and associated products. . . . **Rowe Machinery and Mfg. Co.** has moved into its new plant and offices in Dallas, Tex. . . . **DeVilbiss Co.** has formed a new wholly owned subsidiary called DeVilbiss Metal Fabricators Co. to provide complete finishing systems to industry. The new firm is the result of the consolidation of the Peters-Dalton Div., Detroit Harvester Co. and the Newcomb-DeVilbiss Co. . . . **Pyrometer Co. of America** has been formed in Penndel, Pa., to manufacture instruments, thermocouples, and accessories. . . . **Wiedemann Machine Co.** has moved into its new 76,200 sq ft plant in King of Prussia, Pa. Chief activity of the company will continue to be the manufacture of turret punch presses. . . . **Wheelabrator Corp.** has acquired the assets of Crandall Engineering and Mfg. Inc. and has renamed it the Techline Division. The new division will manufacture and sell barrel finishing machines and wet blast equipment. . . . **George Harmon and Associates** is the name of a new manufacturers design service formed in South Bend, Ind. The new firm will design special and automated production machines, mechanical handlers and loaders, and control systems. . . . **Acoustica Associates Inc.** has acquired General Ultrasonic Co. and will operate it as a wholly owned subsidiary. Both companies manufacture ultrasonic equipment used in military and industrial applications. . . . **Texas Instruments Inc.** has built a new 310,000 sq ft plant in Dallas, Tex., for the manufacture of transistors and other semiconductor devices.

MEETINGS AND EVENTS

Sept. 7-12—
American Chemical Society. National Chemical Exposition and Conference to be held at International Amphitheatre, Chicago. Additional information is available from ACS headquarters, 1155 16th St. N.W., Washington 6, D. C.

Sept. 15-17—
American Society of Mechanical Engineers. Process Industries Conference to be held at Hotel Statler, Buffalo, N. Y. Additional information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

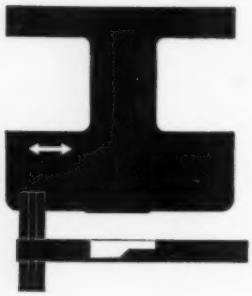
Sept. 15-19—
Instrument Society of America.

New turning idea is born...

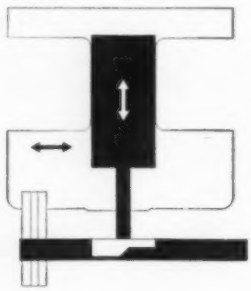
1. Problem workpiece—spiral rotor for pumps. Roots-Connersville Blower Co., Connersville, Indiana, had been machining these rotors on a shaper. The trouble was . . .

2. Shaping just couldn't produce the wide variety of exact contours their engineers wanted. Could rotors be *turned*—automatically?

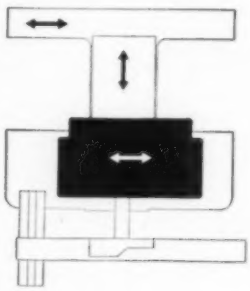
3. Why not? With special end gearing and full nut, we can "chase" the spiral shape like a coarse thread. That's easy . . . the problem is the contour.



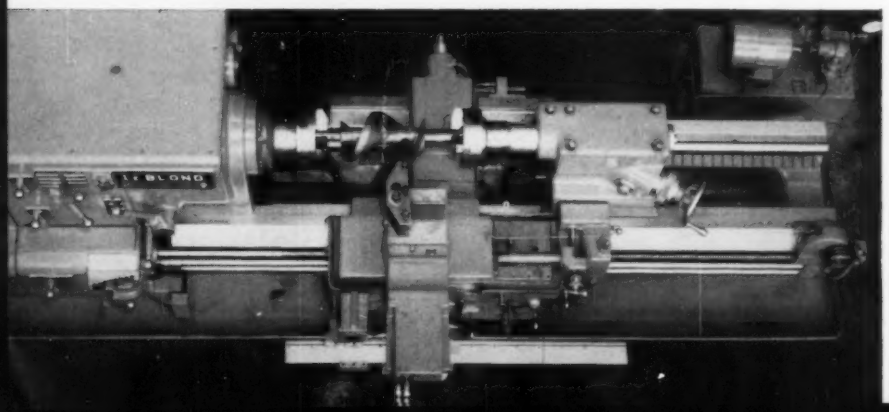
6. Let's see how this looks in plan. The carriage provides length motion for the tool. The template carrier moves lengthwise with the carriage.



7. The cross slide gives cross travel plus automatic tool relief. The template carrier also moves "in and out" with the cross slide.

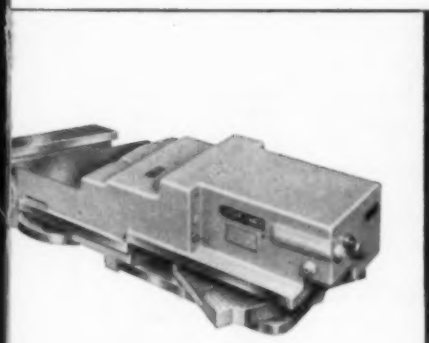


8. The special length slide gives us feed. Not continuous feed. Just tool-positioning feed that moves the stylus slightly along the template for each successive cut.



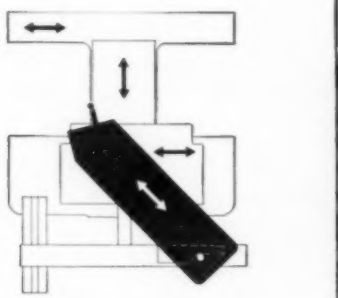
11. Here's the finished machine—the LeBlond Contour Chasing Lathe, basically a 32″ Standard Duty. Modifications include: special end-gearing, full nut, special length slide, automatic cycling and special heavy duty reversing electrics.

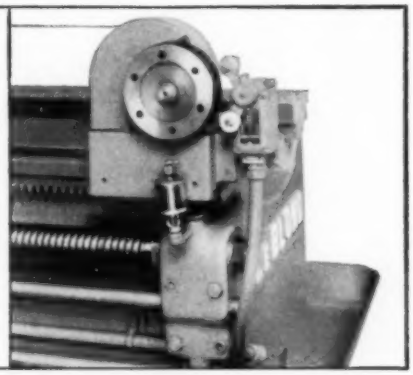
LeBlond Engineers turn trick with tracer



4. How about using Hydra-Trace? We've produced plenty of close tolerance contours with Hydra-Trace.

5. We'll use Hydra-Trace to *position* the tool (not to trace). We can mount a special length slide on the cross slide to give us feed *between* cuts.

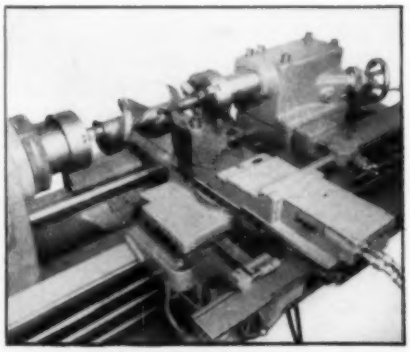




9. The template controlled Hydra-Trace positions the tool for each successive cut to produce the contour. During the cut, no feed takes place. Only the chasing action.

10. One more detail. Remember, the whole action must be automatic. We'll need automatic cycling and a tool release mechanism. That does it.

12. Rotor workpiece shown has 10″ lead— concave on one side, convex on the other. (Lathe chases leads from 4½″ to 16″.) On the left hand rotor, cutting is from headstock to tailstock. On mating right hand rotor, from tailstock to headstock.



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We welcome the opportunity to solve your special turning problems. Tell us about them. Call or write for an engineering appointment.

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World's Largest Builder of a Complete Line of Lathes for More than 71 Years

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Specified wherever long-term operating reliability is a must in light-actuated plant equipment. Available in a variety of spectral responses and sensitivity ratings. At RCA Industrial Tube Distributors everywhere.

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Electron Tube Division **Harrison, N. J.**

Plant Engineers, Maintenance Men! Get this handy booklet (CRPD-105A) which covers RCA gas and vacuum phototubes, photosensitive devices, and cathode-ray tubes. Free—from RCA Commercial Engineering, Section 1-85-T, Harrison, N. J.

13th Annual Instrument-Automation Conference and Exhibit to be held at Convention Hall, Philadelphia. Further information is available from Fred J. Tabery, 3443 S. Hill St., Los Angeles 7, Calif.

Sept. 22-24—

Standards Engineers Society. Seventh Annual Meeting to be held at the Benjamin Franklin Hotel, Philadelphia. Additional information is available from F. F. Van Atta, 1916 Race St., Philadelphia 3, Pa.

Sept. 24-25—

Seventh Annual Conference On Industrial Electronics. Sponsored by the Institute of Radio Engineers and the American Institute of Electrical Engineers, conference will be held at the Engineering Society of Detroit, Detroit. For further information contact H. W. Patton, Acromag Inc., 22519 Telegraph Rd., Detroit 41, Mich.

Sept. 29-Oct. 3—

American Society of Tool Engineers. Western Tool Show and ASTE Semiannual Meeting to be held at the Shrine Exposition Hall, Los Angeles. Further information is available from Richard Gebers, ASTE headquarters, 10700 Puritan Ave., Detroit 38, Mich.

Oct. 6-10—

Southern Textile Exposition. Sponsored by the Textile Hall Corp., 20th biennial event will be held at Textile Hall, Greenville, S. C. Additional information is available from H. H. Lesesne, 434 Palmetto State Life Bldg., Columbia 1, S. C.

Oct. 13-15—

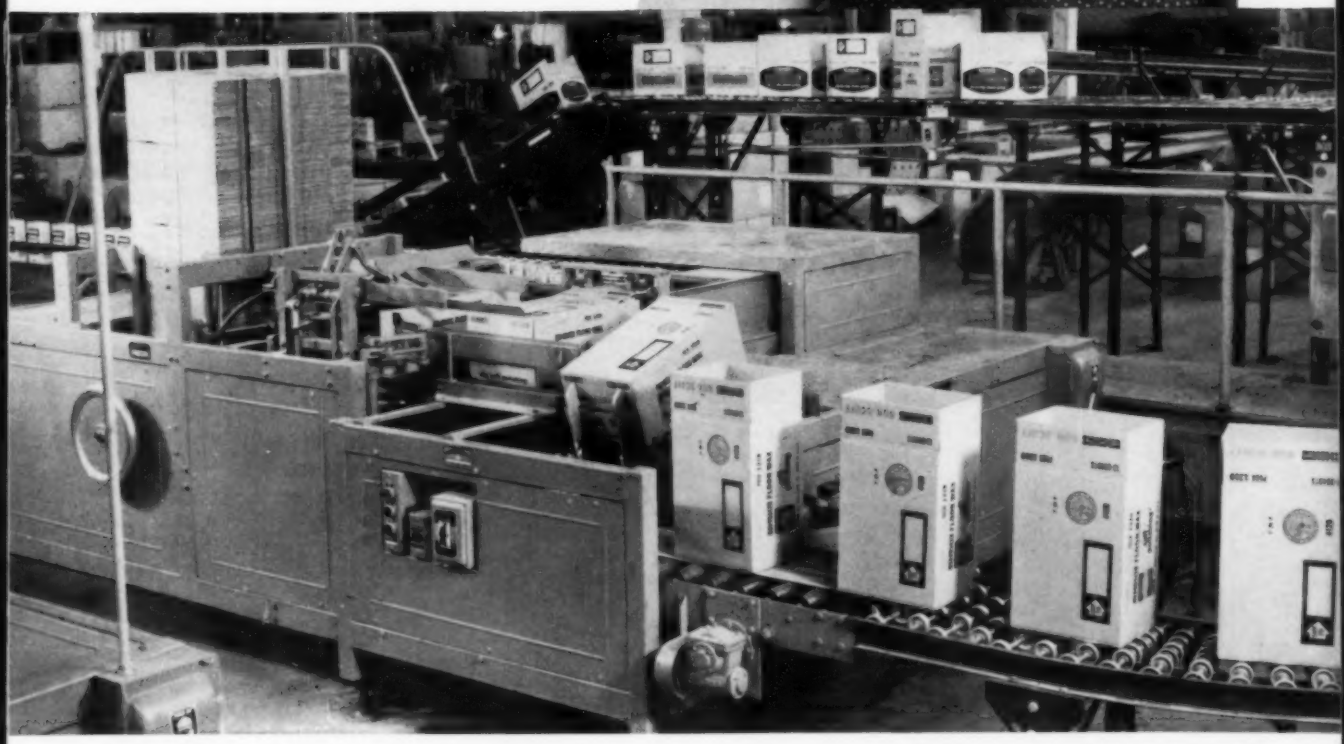
American Institute of Electrical Engineers. Tenth National Machine Tool Conference to be held at Statler Hilton Hotel, Hartford, Conn. Additional information is available from W. P. Carpenter, Superior Electric Co., 83 Laurel St., Bristol, Conn.

Oct. 13-15—

National Electronics Conference. Sponsored by AIEE, IRE, and several universities, conference to be held at Hotel Sherman, Chicago. Additional information is available from Art Streich, NEC, 84 E. Ran-

Simoniz
puts "protection"
in a can

Packomatic®
puts the cans in a case



Packomatic equipment feeds, forms, positions, loads, seals and imprints corrugated shipping containers automatically. However you ship—in multi-ply paper bags, or in corrugated shipping containers; whatever you "package"—a can, a carton, a box or a bale—there's a Packomatic machine designed to handle your shipping container requirements. Packomatic machines, geared to your production line, will feed, form, position, load, seal and imprint corrugated containers automatically—or do any of these operations singly as a complement to your existing packaging facilities. Let one of our sales engineers suggest the start of a long-range packaging program for your plant. Investigate the Packomatic method of cutting costs and boosting production. Call, write or wire today.

Fully-automatic Packomatic Case Former-Loader, part of a fully-automated production line at the Simoniz plant, Kankakee, Illinois. Other Packomatics on the Simoniz line include Case Sealers and Case Imprinters.

Begin to automate your packaging line with this high-speed, fully-automatic Case Sealer. Aligns loaded cases, positions flaps, glues, seals and discharges — and no operator needed! Available in wide range of sizes. Semi-automatic, too. Call or write for additional information.

J. L. FERGUSON CO. Joliet 2, Illinois

PACKOMATICS include the Bale Sealer • Case Sealers • Opener-Loaders • Case Imprinters • Telescoping Volumetric Fillers • Packer-Gluers • Semi-automatic or fully-automatic.

Circle 672 on Page 161

These boxes do everything but balk...

H & D corrugated boxes for shipping Sohio wax start through this machine knocked down. They're set up, packed and sealed—automatically. Would precision packaging speed up your operations? Better see H & D.

HINDE & DAUCH

Division of West Virginia Pulp and Paper Company

AUTHORITY ON PACKAGING • SANDUSKY, OHIO
15 FACTORIES • 42 SALES OFFICES

dolph St., Chicago 1, Ill.

Oct. 13-15—

Systems and Procedures Association. Eleventh Annual International Systems Meeting to be held at Penn-Sheraton Hotel, Pittsburgh. Further information is available from A. M. Motter, Jones & Laughlin Steel Corp., #3 Gateway Center, Pittsburgh 30, Pa.

Oct. 14-16—

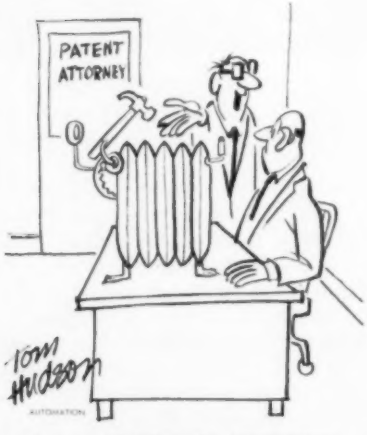
Society of Industrial Packaging and Materials Handling Engineers. National Industrial Packaging, Handling, and Shipping Exposition to be held at the Coliseum, Chicago. Additional information is available from G. Cornwall Spencer, 327 S. LaSalle St., Chicago 4, Ill.

Oct. 16-17—

National Conference on Industrial Hydraulics. Sponsored by Illinois Institute of Technology and the Armour Research Foundation, fourteenth annual conference to be held at Hotel Sherman, Chicago. Further information is available from Raymond D. Meade, Illinois Institute of Technology, 3300 S. Federal St., Chicago 16, Ill.

Oct. 20-22—

American Management Association. Orientation Seminar on Materials Handling and Work Flow For Job Lot Production to be held at the Carter Hotel, Cleveland. Further information may be obtained from Seminar Registration, AMA Headquarters, 1515 Broadway, New York 36, N. Y.



". . . and when the temperature goes down to 60 . . ."

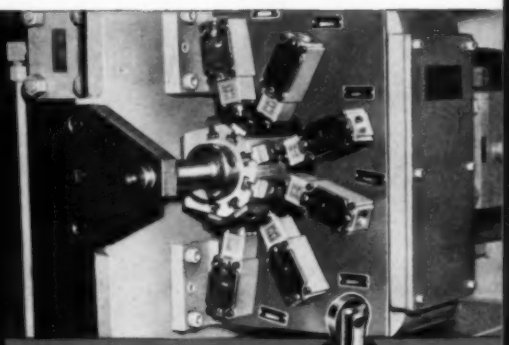
Circle 673 on Page 161

ALLEN-BRADLEY

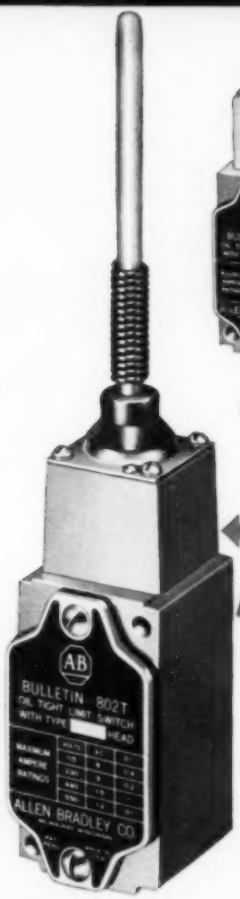
BULLETIN 802T

OILTIGHT

LIMIT SWITCHES



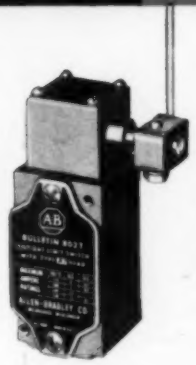
Radial mounting of six Allen-Bradley "manifold" type, push roller, oiltight limit switches.



WOBBLE STICK TYPE

SIDE PUSH ROD

FORK LEVER TYPE



ADJUSTABLE ROD

TOP PUSH ROD WITH PLASTIC WINDOW

Push roller, oiltight limit switch, showing rubber grommeted wiring hole on back of "manifold" type, used on above automatic production machine made by Cross Company, Detroit.

OIL SEALED HEAD AND BODY

assure reliable operation

Completely sealed . . . oil, dirt, and metal chips cannot foul up contacts or operating mechanism. Operating heads are interchangeable—can be mounted in any one of four positions. New "wobble stick" heads operate in any direction. All of these limit switches have maintenance free, double break, silver alloy contacts. Specify Allen-Bradley—the *quality* line of limit switches.

ROLLER LEVER FOR CAVITY MOUNTING

ADJUSTABLE ROLLER LEVER

A-B QUALITY

ALLEN-BRADLEY

MOTOR CONTROL

QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
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9-59-R

THE ONLY LINE OF

D. C.
MOTOR STARTERS
with modern
SOLENOID CONTACTORS

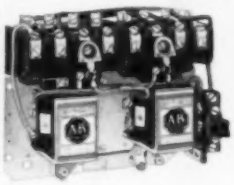
A-B QUALITY

With Allen-Bradley, you get D. C. motor control that is *completely modern!* It uses the simplest switching mechanism yet conceived . . . the solenoid contactor with only ONE moving part. There are no bearings to stick . . . no jumpers to break. This assures millions of trouble free operations. And the double break, silver alloy contacts never need maintenance. Available in ratings up through Size 4. Write for details.

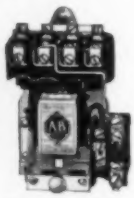
CONTACTORS

Bulletin 202 solenoid type contactor. In ratings to 150 amp. Also, clapper type to 600 amperes.

FULL VOLTAGE STARTERS

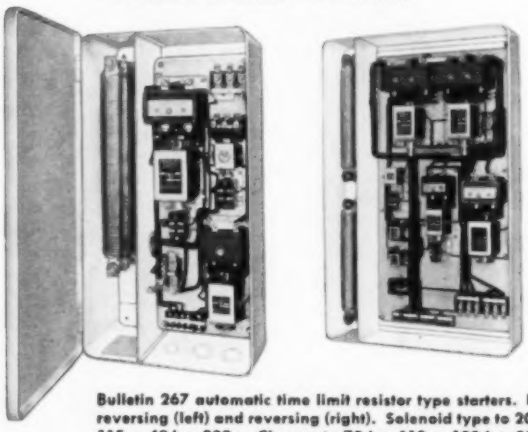


Bulletin 205 full voltage reversing starter. Ratings to 1½ hp, 115 v; 2 hp, 230 v.



Bulletin 209 full voltage starter. Available in ratings up to 1½ hp, 115 v; 2 hp, 230 v.

REDUCED VOLTAGE STARTERS



Bulletin 267 automatic time limit resistor type starters. Non-reversing (left) and reversing (right). Solenoid type to 20 hp, 115 v; 40 hp, 230 v. Clapper to 75 hp, 115 v; 150 hp, 230 v.

9-58-MR

ALLEN-BRADLEY
MOTOR CONTROL
QUALITY

MAIN OFFICE and Factory
1316 S. Second St.
Milwaukee 4, Wis.

In Canada: Allen-Bradley Canada Ltd., Galt, Ontario

By JAMES C. KEEBLER Managing Editor

Courtesy, Link-Belt Co.

At Mercury's Rivera, Calif. assembly plant, traffic through first half of trim department is controlled from this master control console. It is the operator's job to transfer bodies from one operation to another. Ten pushbuttons at front of panel control live roll and lift tables which lift body from side transfer conveyor and move it at right angles onto one of the trim or storage conveyors, or vice versa.

HANDLING AUTOMATION

EXPERTS on automation generally agree that when the dreams and plans of any automation program are transformed into production facilities there are three primary functions that must be included in the thinking.

The Big Three

1. The *work performing* function pertains to the steps of the process that alter or combine materials in process. 2. The *handling* function pertains to the movement of materials in process (either within machines or between machines). 3. The *control* function that accomplishes the automatic cycling of work performing and handling equipment either independently or in an interlocked fashion.

In some installations the primary emphasis is placed on one particular item of this big three. In others unique combinations of these functions contribute largely to the success of the process. Yet it is rare indeed to find an automated operation that does not encompass achievements or potential in all three functions.

Each of these functions (work performing, handling, and control) involves a broad enough technology that it is sometimes considered as a specialty in itself. Because different products require different processes of manufacture, and different quantities of production may dictate variations of basic processes, it is natural that these factors result in special emphasis on one or the other of the three basic functions that make up an automated installation.

Because of the variety of parts and materials that go into the modern automobile, it is difficult (for the purposes of classifying automation specialties) to conceive of automobile manufacture as one single industry. Devising production facilities for the manufacture of pistons calls upon a different set of specialties than does the establishment of lines for the final assembly of automobiles. The former shows evidence of special emphasis on the work performing function while the latter has a preponderance of the handling function.

Snips and Snails

It would appear then, that when studying, "What are little automakers automated facilities made of?" one should get more specific in his frame of reference than simply "automaker."

Care must be taken or the issue will be as confused as an attempt to analyze the results of a survey without knowing what the questions were.

Take an assembly plant for instance. (*Assembly plants are easy to take because there are so many of them—Chevrolet has* 12 *from coast to coast, Plymouth's latest is being built* 20 *miles out of St. Louis, Ford Motor Co. has built* 13 *since World War II, five of these are for Mercury, the latest at Rivera, Calif.*) Here the problem is to bring together all of the parts and subassemblies required to put together the complete vehicle. This in itself is such a big problem that most of the parts in question are made under other roofs.

and Puppy Dog's Tails

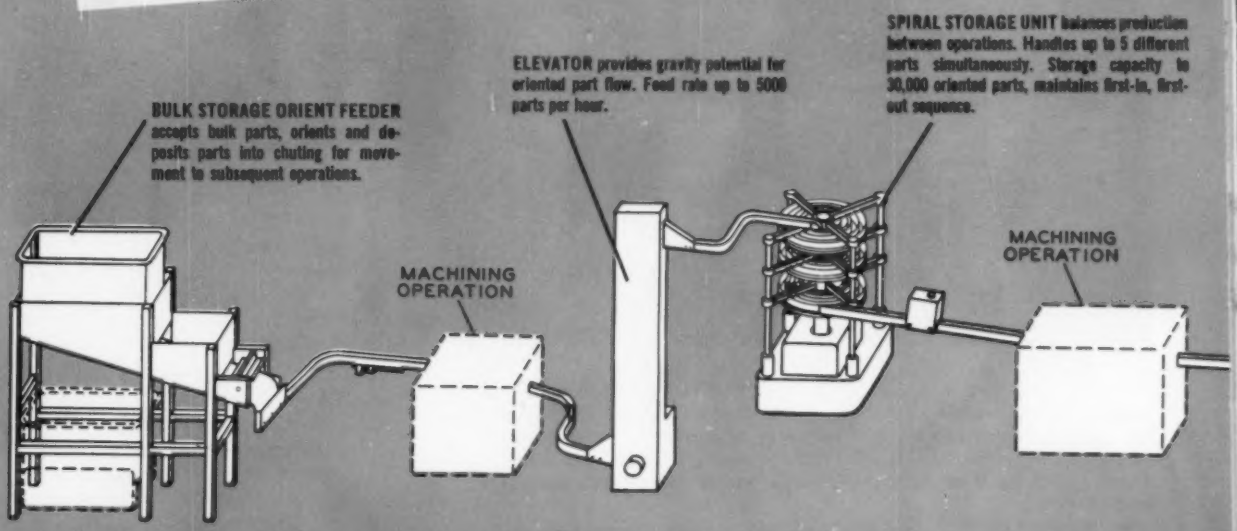
Though this is primarily a handling problem, those who ply the trade are quick to advise that there's more to it than that.

Just as the manufacturing engineers who make pistons talk about **integrated** handling operations that tie their workstations together, so the engineers who bring automobile parts together talk about **integrated** handling operations that prevent the most probable source of a production bottleneck—disruption of material flow.

Ford's integrated material handling system was described for a recent AMA Packaging Conference by C. L. Hanchett, supervisor, Material Handling Engineering and Inventory Planning and Handling, and

NEW IDEAS IN AUTOMATIC

A NEW CONCEPT FOR AUTOMATION THAT IS ECONOMICAL, EFFICIENT, FLEXIBLE AND NON-OBSOLESCENT


BULK STORAGE ORIENT FEEDER accepts bulk parts, orients and deposits parts into chuting for movement to subsequent operations.
ELEVATOR provides gravity potential for oriented part flow. Feed rate up to 5000 parts per hour.
SPIRAL STORAGE UNIT balances production between operations. Handles up to 5 different parts simultaneously. Storage capacity to 30,000 oriented parts, maintains first-in, first-out sequence.
MACHINING OPERATION
MACHINING OPERATION

LAMB Offers NEW LINE of Standard Units Having Unusual Versatility. One or More Will Solve Almost any Parts Handling Problem Using Existing Production Equipment.

Automatic parts movement between operations saves time, space and money. Until now, the specialized nature of such handling systems could not justify their cost except for long run production of parts that seldom required redesign.

The F. Jos. Lamb Co. has overcome this high cost factor by eliminating special design and providing flexibility in standardized units. Lamb standardization and flexibility in automatic parts handling equipment means that many of the benefits of automation are available at very low cost, simply by integrating existing production machine tools by the use of one or more Lamb components.

Added savings are realized when part design change, new part production and/or processing change would normally obsolete other systems. It means that many manufacturers who believe their operation is too small or unsuited to automated methods can now apply automation to a single process or to an entire plant.

The Lamb concept of "packaged" automation provides a separate component for each automated function. One unit orients bulk parts. Another elevates parts for gravity potential. There is one that stores and feeds parts to balance production. Still another divides part flow to feed production from a fast cycling machine to two or more slower operations. Line interlocks control part flow and provide an electrical signal to control machine functions. All machines and the parts

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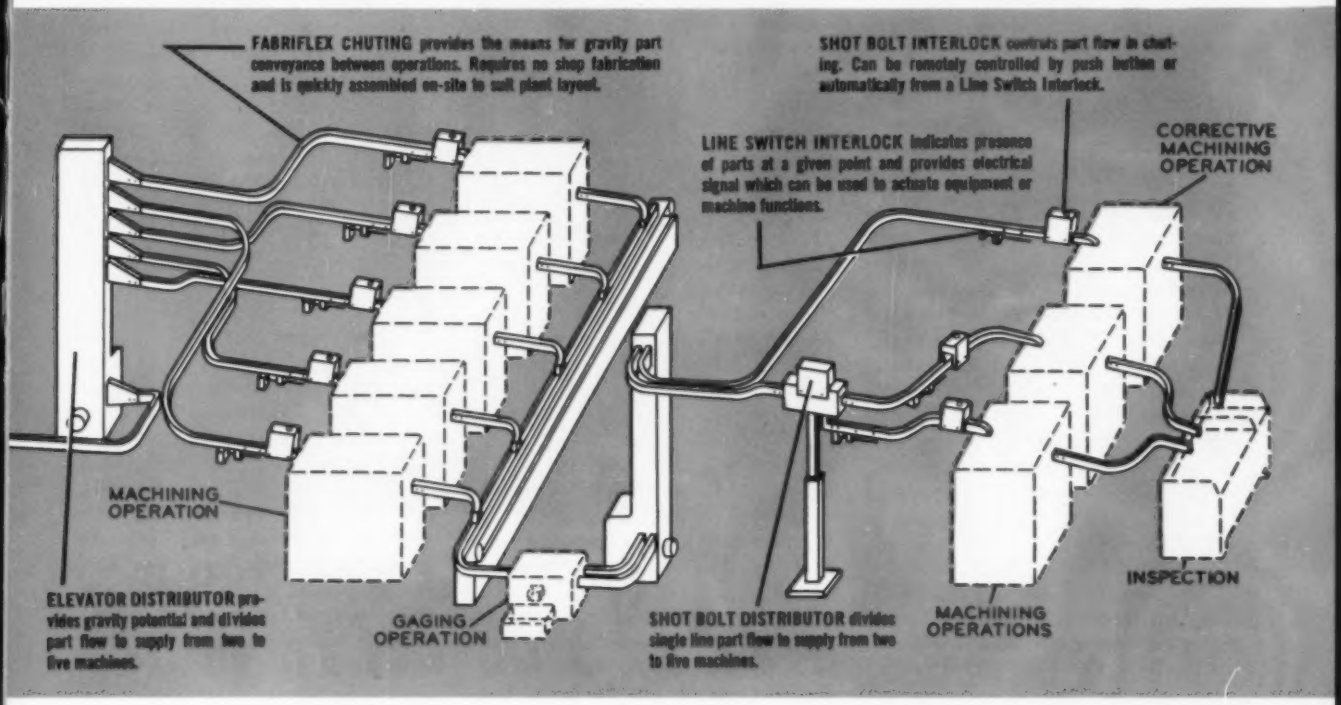
F. JOS. LAMB CO.

P. O. Box 4611 • 5663 E. Nine Mile Road • Detroit 34, Michigan

PARTS HANDLING (and storage)

That CUT COSTS


FABRIFLEX CHUTING provides the means for gravity part conveyance between operations. Requires no shop fabrication and is quickly assembled on-site to suit plant layout.
SHOT BOLT INTERLOCK controls part flow in chuting. Can be remotely controlled by push button or automatically from a Line Switch Interlock.
LINE SWITCH INTERLOCK indicates presence of parts at a given point and provides electrical signal which can be used to actuate equipment or machine functions.
CORRECTIVE MACHINING OPERATION
MACHINING OPERATION
ELEVATOR DISTRIBUTOR provides gravity potential and divides part flow to supply from two to five machines.
GAGING OPERATION
SHOT BOLT DISTRIBUTOR divides single line part flow to supply from two to five machines.
MACHINING OPERATIONS
INSPECTION

handling units are tied together with Lamb FabriFlex Chuting which conveys parts between operations by gravity motivation. The drawing above illustrates the versatility of a Lamb system.

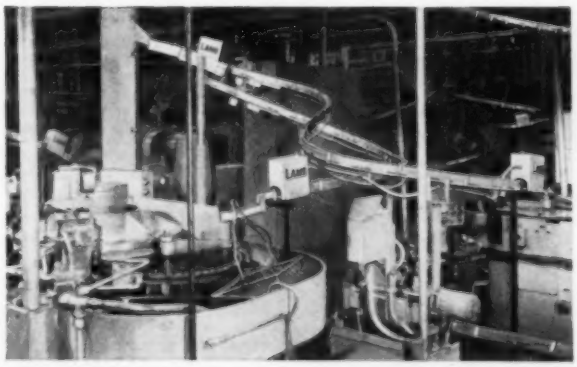
Investigate the advantages of this new concept today. Call in a Lamb engineer; his experience qualifies him to suggest ideas for cutting handling costs, increasing production, reducing down time, balancing production and automating your manufacturing using the equipment now in your plant.

8132

Write for this NEW Bulletin. It will give you Numerous Ideas on How to Cut Parts Handling Costs.

SINCE 1914

Engineers and Builders of Special Machines and Automation Equipment



This photograph shows Lamb Parts Handling Units used in the production of transmission gears. An elevator, flow divider, line interlocks and chuting are installed where required to provide completely automatic production. Normally, Lamb components can be installed without altering plant layout.

A

F. JOS. LAMB CO.
P.O. BOX 4611, 5663 E. NINE MILE ROAD
DETROIT 34, MICH.

Please send me without obligation a copy of bulletin 58-01
LAMB AUTOMATIC PARTS HANDLING AND STORAGE

Name_____

Title_____

Company_____

Address_____

Walter H. Albrecht, supervisor, Handling Methods and Equipment Unit, Material Handling Engineering, Ford Div.

This is a plan wherein the individual requirements and interdependent relationships of product design, packaging, shipping, control, and intraplant handling are analyzed to develop methods that will effect the most economical movement and storage of materials.

The inventory planning function is concerned with the most economical balance of material float and standard package quantities as well as facility and equipment costs for handling and storing materials.

Major List

As major considerations in the formulation of a handling system for a specific assembly plant Albrecht listed the following: The amount of stock storage area needed, receival methods and quantities, types and quantities of material handling equipment, and building configuration. Factors that influence plant layout include the stock storage area required, production equipment space requirements, and the aisle area needed for the flow of material.

The packaging phase of the Ford program reads like the Buick "palletization" program announced in 1956. By working out package sizes with suppliers the assembly plant cut handling and storage costs and in general cut packing costs for suppliers.

Where 10 steering wheels used to come in one cardboard carton with a stapled cover, 156 now arrive in four open-faced boxes with a single lid which lifts off easily. Radios used to be shipped two to a box which was small enough to be tossed around — and dropped frequently with resultant damage. Now they come 80 to a carton, all under one top.

New Big M

Integrated handling in the new Mercury plant at Rivera, Calif. means refinements over previous plants, including a higher degree of automatic handling, better timing, and improved spacing arrangements.

Automatic transfers play an important part in the movement of car bodies and parts throughout the plant. Many of these transfers require neither people nor pushbuttons. The bodies can travel along one conveyor to the end, be picked up by a transfer conveyor which carries it at right angles, and then be transferred to a third conveyor parallel to the first, entirely automatically.

Where selection of conveyor is necessary, pushbuttons permit bodies to be transferred readily to the desired location. In the body trim department, for example, a dual-chain side-transfer conveyor can be set by the operator to perform 32 different transfers, tying together 21 different conveyors. This permits bodies to be routed through pre-trim and electrical lines, No. 1 and No. 2 trim lines, station wagon trim lines, repair lines, etc., as required.

Link-Belt has announced with pride the role it played in supplying handling equipment. Besides 122 chain conveyors there are 26 powered roll and two belt conveyors. In addition, Link-Belt furnished 98 hydraulic live roll and lift tables, six gravity roll and lift tables, 15 transfer tables, five hold tables, six turntables, a track-mounted transfer car and over 2,000 ft of gravity rolls.

Along with these were furnished bearings, speed reducers, chains, drives, and all of the other components for the conveyors. In addition, they installed all electrical controls and field wiring for the floor conveyor system and designed all electrical equipment in conjunction with Cutler-Hammer Co. The conveyor system required 35 separate hydraulic systems that were furnished as part of the contract and were designed and installed in conjunction with the Rucker Co., Oakland, Calif.

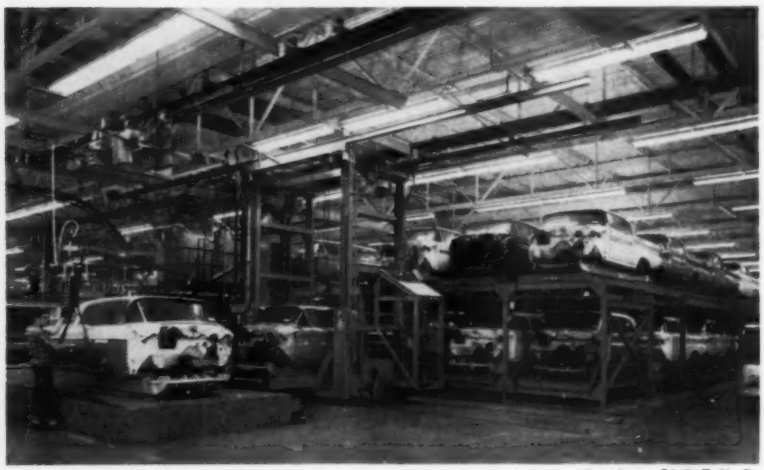
Integral Part

Since the conveyors are part of the assembly operations, the majority are equipped to run at variable speeds with electronic speed controls. Some of the conveyors, specifically those in final assembly, have spare drives connected by jaw clutches.

The basic engineering and sequencing requirements of the plant equipment were designed by the Mercury plant engineering department in Detroit, where Link-Belt set up an engineering office for the job of detail engineering.

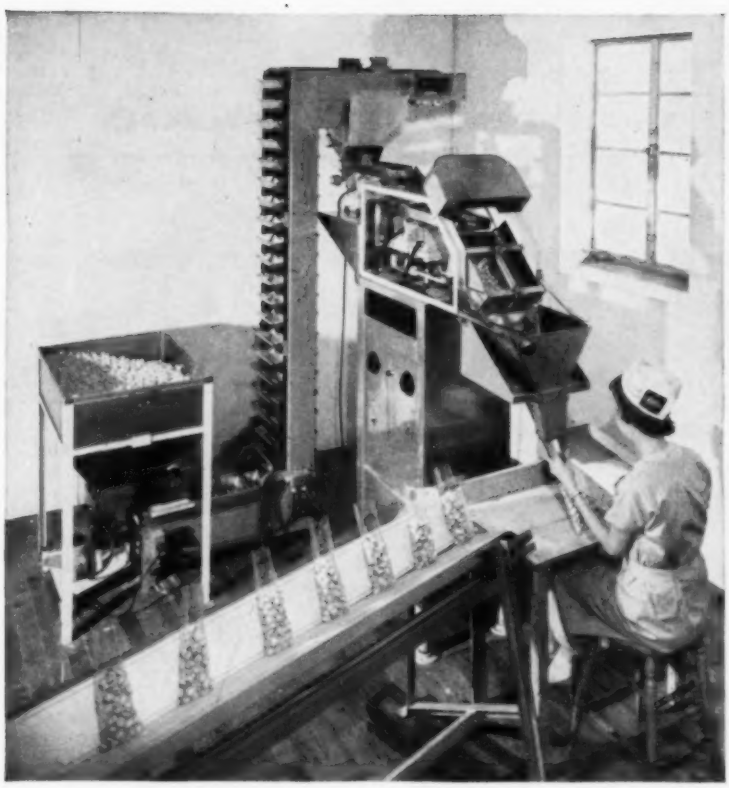
Manufacture of the conveyors and related equipment was divided between Los Angeles and San Francisco in order to utilize the productive capacities of the two closest plants.

Auto assembly plants illustrate increasing application of automatic operations with an emphasis on handling—closely integrated by a control system with the work to be performed.



Courtesy, Link-Belt Co.

Ninety Mercury finished bodies can be stored ahead of final assembly line on ten storage conveyors, five on floor level, five directly above them. The bodies are removed in desired sequence from any conveyor, as required for scheduling, by a traveling elevator which operates like a "pigeon-hole parker." Operator transfers body to sling of overhead rail conveyor for transport to body drop station of assembly line.



Sweet and Gentle... The Story at Wayne Candies

Wayne Candies, Inc. Fort Wayne, Indiana, recently installed a Wey-Mor automatic weighing and bag-filling machine to provide gentle treatment to a wide variety of candies. The equipment is used to handle items Wayne manufactures as well as those it re-packages under its own label. Some of the items handled on the Wey-Mor include Flavored Puffs, Cinnamon Imperials, Rum & Butter Toffee, Pineapple Slices, Rainbow Mints and a wide variety of other items.

Since installing the equipment, Wayne Candies has increased its production enough to save 10% on bagging costs and has reduced material losses by approximately 50%.

Extremely smooth, fast delivery is particularly important to assure perfect package appearance of a fragile candy like Wayne's Flavored Puffs. Wey-Mor meets all requirements because it features a vibratory feed along its entire length, not just at the bulk and dribble point. This eliminates friction and breakage of the candy.

Wey-Mor will be a "sweet" addition to your packaging operation! See how it can improve your product's appearance and cut your production costs. Write for full information.

Write for Illustrated Wey-Mor Folder that demonstrates true flexibility in production-line weighing.

Close-up shows detail of Lynch Wey-Mor. Vibratory feeder brings product forward to the bulk (2 outside channels) and dribble (center channel) point. Machine is quickly adjusted for any amount from 8 to 16 ounces . . . automatically discharges when proper weight is reached.

Wayne's packaging team includes a Lynch Robo-Lift which is synchronized with the Wey-Mor scale to assure a steady flow of candy. One girl keeps hopper filled, one handles filled bags, one labels them and another cases the finished product.

These are among the items Wayne Candies, Inc. packages with their Wey-Mor Automatic Weighing Machine: Flavored Puffs, Cinnamon Imperials, Rum & Butter Toffee, Pineapple Slices and Rainbow Mints are among the hundreds of varied items bagged on this high speed machine.

LYNCH
CORPORATION
Anderson, Indiana

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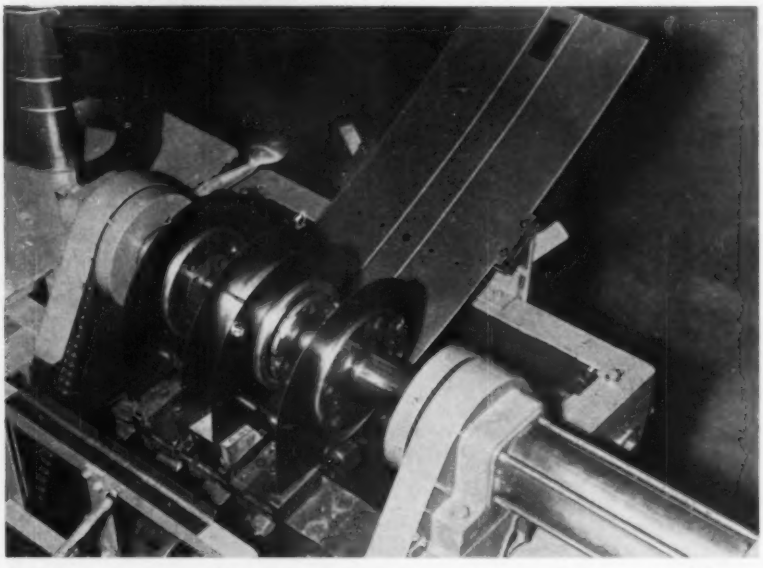


Welding head of modified Stryco spotwelder which jigs, forms, and welds five components to produce a dual blower scroll. As shown, four plates have been positioned in jig and scroll wrapper inserted, ready to be formed around the plates and welded to tabs on the plates.

Here and There

LOCALIZED automation on an otherwise conventional, unautomated production line, is being featured in many of the more progressive west coast plants. Typical of "spot" automation is the custom-built Stryco Mfg. Co. resistance welder used at Trade-Wind Motorfans Inc. to jig, form, weld, and complete a dual blower scroll for a ventilating fan.

The five stamped parts used to produce this component are shown in the accompanying photograph jigged in the holding fixture on the resistance welder ready for forming and welding. The primary reason for turning to more automatic production equipment in this particular case was that the five stamped parts were difficult to jig in the usual manner and then weld on a conventional spotwelder. The time element involved was also a costly factor.

Limit switches, timed contacts, and relays are used to sequence and control the spotwelder. It contains two aligned rows of four spotwelding electrodes each. These electrodes are sequenced to weld two at a time rather than four at a time thus reducing current demands and the original cost of the welding transformer.

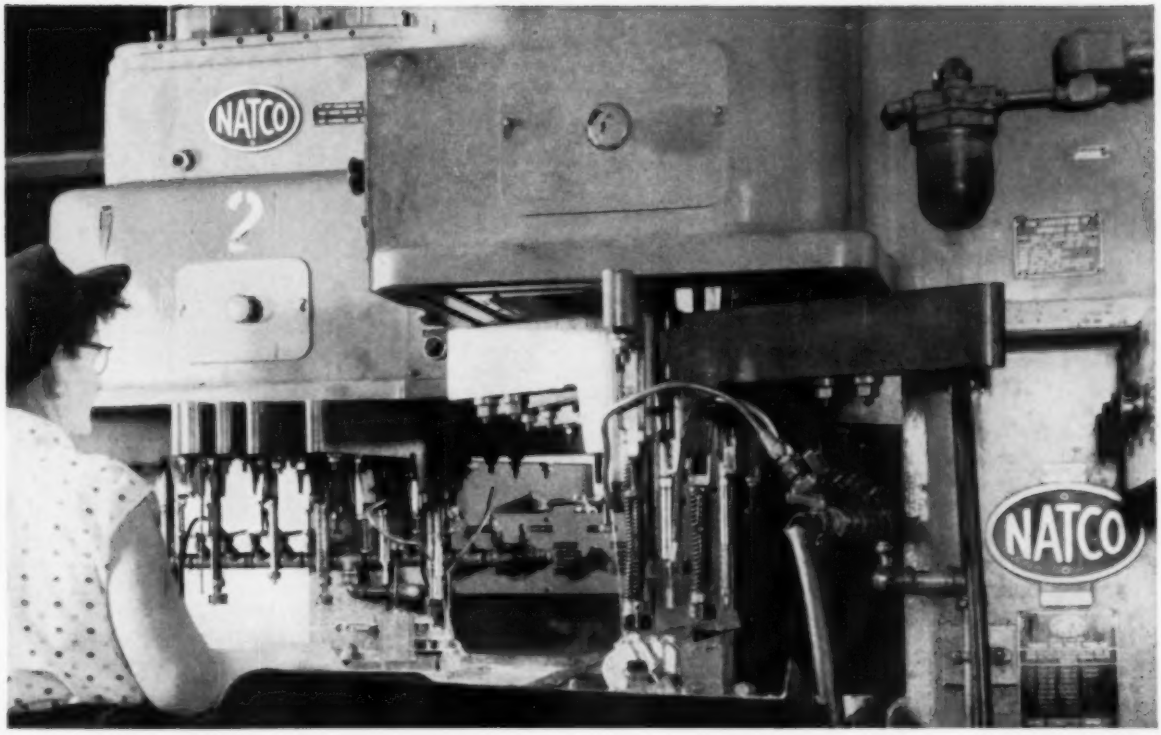
In brief, this is how it operates during an automatic cycle in which a formed and welded dual blower scroll is produced: At the beginning of the cycle, a hydraulic clamping cylinder is in a retracted position and the clamps which hold the four scroll plates are open. The operator inserts the scroll plates in the positions shown in the illustration and presses a switch which actuates a cylinder, clamping (or jigging) the scroll plates firmly in place. Next, one end of the stamped scroll wrapper is placed under the scroll plates and between one row of four spotwelding electrodes. Here another set of clamps holds it firmly in place. At this point the automatic cycle is started by pressing a switch.

The first row of four aligned electrodes, operating two at a time, first spotweld the inserted end of the scroll wrapper to tabs on the scroll plates. Next, a hydraulically actuated arm rises beneath the outer end of the scroll wrapper and folds it up, over, and around the scroll plates. At the completion of the fold-over operation, the loose end of the scroll wrapper fits between the second row of four aligned electrodes. This second row of electrodes then completes the welding of the scroll plates to the scroll wrapper, two spots at a time. As the scroll wrapper is grooved during blanking, the scroll plates fit into the grooves and intermediate welding between the two end welds is not necessary.

With the welding cycle complete, the machine shuts off automatically, the scroll wrapper clamps and the hydraulic cylinder clamps open, and the finished dual scroll blower can be lifted out. The machine stops in a position so that it is ready for the next group of blower parts.

While no accurate production time records have been kept on this automated spotwelder, company officials state flatly that it is "many, many times faster than the old method of first jigging the parts, then welding them on a conventional spotwelder." From a general viewpoint, it is an excellent example of how "spot" automation can be employed to eliminate time-consuming and costly production line bottlenecks in many small firms where automation is still but a dream of the future.

The very size of large plants makes automation seem logical and in many cases it is difficult to imagine how volume production could be obtained in any other manner. Opposed to these circumstances, smaller plants are faced with the problem of working hard to justify automatic equipment and



Ten Natcos like these replaced 170 single spindles!

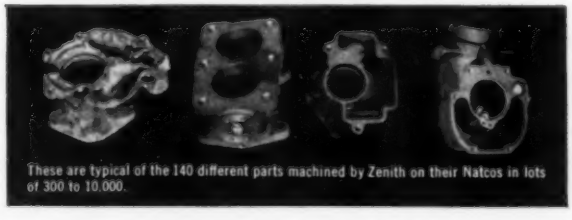
It's "reduce costs or else" in the hotly competitive carburetor business. That's why Zenith Carburetor Div. of Bendix Aviation Corp. embarked on a tooling program which resulted in substantial savings per casting machined.

Ten multiple spindle H-6 Natcos provided the greatest savings per machine dollar spent. By combining drilling and tapping operations, the Natcos eliminated the need for 170 single spindles. Look at the cost comparisons on two parts, for example—a die-cast cover and fuel bowl.

Formerly, the cover was machined by five operators using ten single spindles with ten jigs. The fuel bowl was formerly run by two operators on four single spindles using four individual jigs. Now these parts are run on two Natcos by a single operator at a direct cost savings of 81% on the cover and 70% on the fuel bowl.

Wherever hole-machining operations are performed one at a time, you'll find outstanding opportunities for cost reduction. Standard multi-spindle Natcos range from 1 hp, 10-spindle high-speed machines to giant heavy duties with 50 hp and up to 72 spindles. Natco also builds a complete line of special way-type, index and transfer machines.

A Natco field engineer can help you with your cost-reduction and production problems. Call or write today.



These are typical of the 140 different parts machined by Zenith on their Natcos in lots of 300 to 10,000.

Somewhere in Natco's experience is a money-saving idea for YOU!

NATIONAL AUTOMATIC TOOL COMPANY, INC.

Richmond, Indiana

Natco offices in Chicago, Detroit, New York, Buffalo, Boston, Philadelphia, Cleveland and Los Angeles; distributors in other cities.

NATCO

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techniques. The small plant that thinks in terms of automatic equipment of any type as a solution to a production problem is playing the modern automation game of "how to make profits and stay in business" in accordance with all the rules dictated by our changing technology.

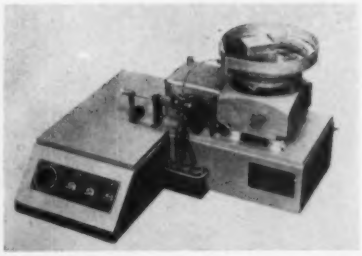
$20 Million Potential . . .

At the annual meeting of stockholders of Topp Industries Inc., several officers of the company gave some indication of the importance of new products to the growth of a company.

As one example, M. J. Peterson, executive vice president, reported that Topp had developed a new system of numerical control for mechanical processes which combined digital and analog techniques. The design of the system is unique enough to give Topp as much as a $35,000 competitive edge in comparison to equal control systems now on the market. Peterson estimates that the current annual volume for numerical controls is approximately $10 million and that it could reach $20 million during the next fiscal year, depending on general economic conditions. Topp expects to capture between 5 to 20 per cent of the market as it develops.

12,000 Per Hour . . .

New techniques in magnetic core testing were demonstrated by Telemeter Magnetics Inc. at the IRE Special Technical Conference on Magnetics in Los Angeles. Using a new automatic core handler, the company showed how they grade 50-mil cores at the rate of 12,000 cores per hour.



Magnetic core tester developed by Ramsey Engineering Co. for Telemeter Magnetics Inc. can process 12,000 cores per hour. The small cores are automatically tested and classified into one of three categories.

The core handler, developed for Telemeter Magnetics by the Ramsey Engineering Co. of St. Paul, Minn., moves a core into position, holds it there by vacuum, inserts a coaxial probe, and makes individual drive and sense circuit connections to permit testing.

Cores are then tested for switching time, peaking time, noise level, output emf, and "knee." The core is then released into one of three containers according to grade. The entire operation is automatic.

The electronics which make such rigorous high speed testing possible were developed by TMI engineers. Telemeter Magnetics Inc. manufactures a variety of storage and switching cores and also makes core arrays, complete memories, and data handling systems.

Bulk Storage . . .

In order to simplify a storage problem, Coastal Valley Canning Co., Oxnard, Calif., has put bulk containers to unique use. The canning company prepares tomato puree for numerous private brand labelers. Working with Gaylord Container Corp., a technique has been developed whereby cans are filled and stored, unlabeled, in a special corrugated bulk container. When a customer's order is received, a container is moved by fork truck from the warehouse to the labeling line where a trap door in the bottom of the container is opened, allowing cans to tumble out onto an unscrambler. After being oriented, cans are labeled and cased for shipment.

How to "Turn on a Dime"

Today, production men must "turn on a dime" to meet changing output requirements. One day sales are off—machines are idle; the next equipment must produce at top speed to meet a rush order. This requires unusual flexibility in both men and machinery.

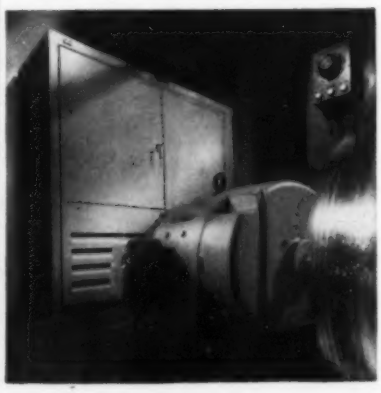
To help solve this problem, General Electric offers a new, packaged, adjustable-speed drive—the Speed Variator. Offering wide speed ranges and good regulation, it can help your machines produce a greater variety of goods, faster and at lower cost per unit.

Find out how this versatile new drive can help you keep pace with today's fast changing production demands. Write for GEA-6643. *Direct Current Motor and Generator Department, Erie, Pennsylvania.*

813-20A

Progress Is Our Most Important Product

GENERAL ELECTRIC



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5 REASONS WHY YOU SHOULD BUY

New General Electric Speed Variator

1. Amplistat Regulator offers better speed regulation and adjustable, timed acceleration for improved product quality.

2. Static Exciter, with silicon rectifier, has no moving parts, requires no warm-up, provides more production time, less maintenance.

3. Two-Unit, Four-Bearing M-G Set features Tri-Clad† '55' motor for more dependable performance.

4. Front-Connected Controls, recessed wiring troughs make routine inspection easy, cut maintenance time.

5. Kinamatic* Drive Motors provide extra power to meet peak loads. For details on this powerful motor see next page.

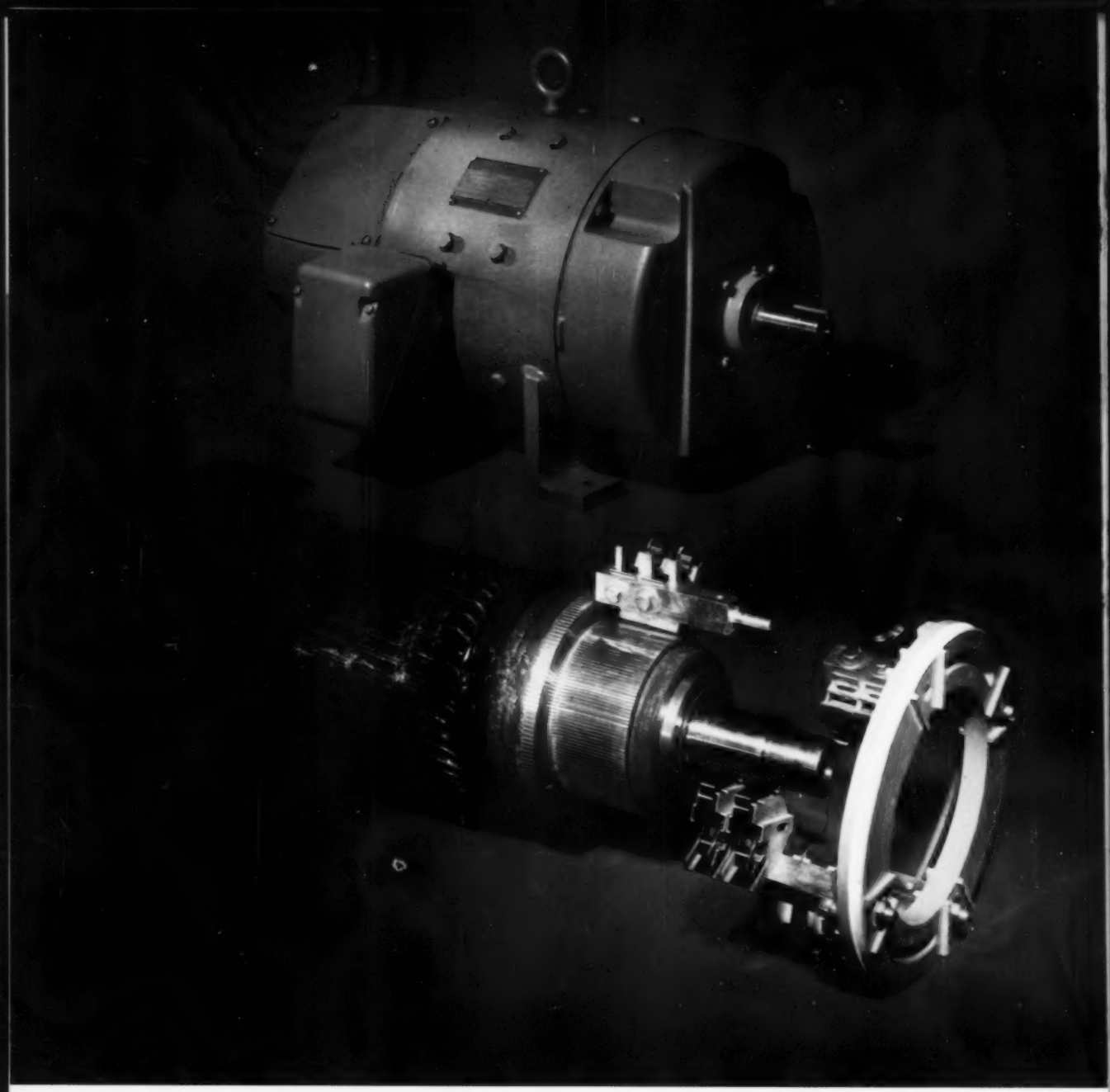
For more information contact your Apparatus Sales Office or write for GEA-6643. *Direct Current Motor & Generator Department, Erie, Pennsylvania.*

In Canada, contact Canadian General Electric, Peterborough, Ontario.

† *Registered Trade Mark General Electric Co.*
* *Trade-Mark of the General Electric Co.* 813-19

GENERAL ELECTRIC

More On Kinamatic Motors



NEW GENERAL ELECTRIC DC MOTOR GIVES

Extra Power To Meet Peak Loads

KINAMATIC* ... *a new standard in industrial direct-current motors* . . . designed to meet the vital power load requirements of modern manufacturing methods.

Proper Design Balance . . . means unmatched commutating ability . . . the ability to deliver the short bursts of power required for quick acceleration and deceleration. Fewer turns per armature coil . . . full complement of commutating poles . . . maximum number of commutator segments, combine to permit higher peak loads.

New Brush Assembly . . . constant-pressure brush springs eliminate brush adjustments. Bronze, corrosion-resistant brush holders are mounted on square steel studs for stable operation in both directions of rotation. Molded polyester-glass yoke resists impact, intense heat and corrosion.

D-c Kinamatic Motors offer a reliable key to successful automation. Additional information is available at your nearest General Electric Apparatus Sales Office. Or, if you prefer, write for Bulletin GEA-6355, *Direct Current Motor and Generator Department, Erie, Pennsylvania.*

*Trade-Mark of General Electric Company. 813-11

Progress Is Our Most Important Product

GENERAL ELECTRIC

One Way

Standards are like a two-way street. Used properly they can create tremendous savings and literally make low-cost mass production possible. NEMA and AGMA standards are good examples. On the other hand, wrongly applied standards can create stagnation, stifle development, and add to costs. Standards are not designed to place a lid on the progress of engineering development.

There are instances where JIC electrical standards have done the latter. Improperly insisted on as a rigid purchasing specification without concern for environmental and operating requirements or for new developments, such standards can increase equipment costs significantly, often without advantage otherwise.

By utilizing electrical standards such as these as a quality platform from which to develop and improve installations, most economic results can be obtained. For instance, through new and unique electrical control system design—employing such devices as telephone switching equipment, miniaturized controls and static control units—significant reductions in panel size can be attained, even with more intricate systems. With the increasing size and complexity of automatic equipment, compact controls are a must.

Likewise, reliability takes on increasing importance. Continuous lines may be highly vulnerable in the event any failure occurs. Operations dependent upon limited time or fixed cycle processing may "pile up" at one point and foul a large volume of material; those dependent on specific sequences of operations may create uneconomic quantities of scrap.

Today, in some installations, these new approaches to control of operations have resulted in reduction of maintenance to routine quarterly checkups under continuous operation. Necessary progress in the evolution of improved control systems accompanied by lower initial cost and upkeep can be assured by rational use of electrical standards by both the equipment user and builder. Let's keep headed down the street in the right direction.

EDITOR

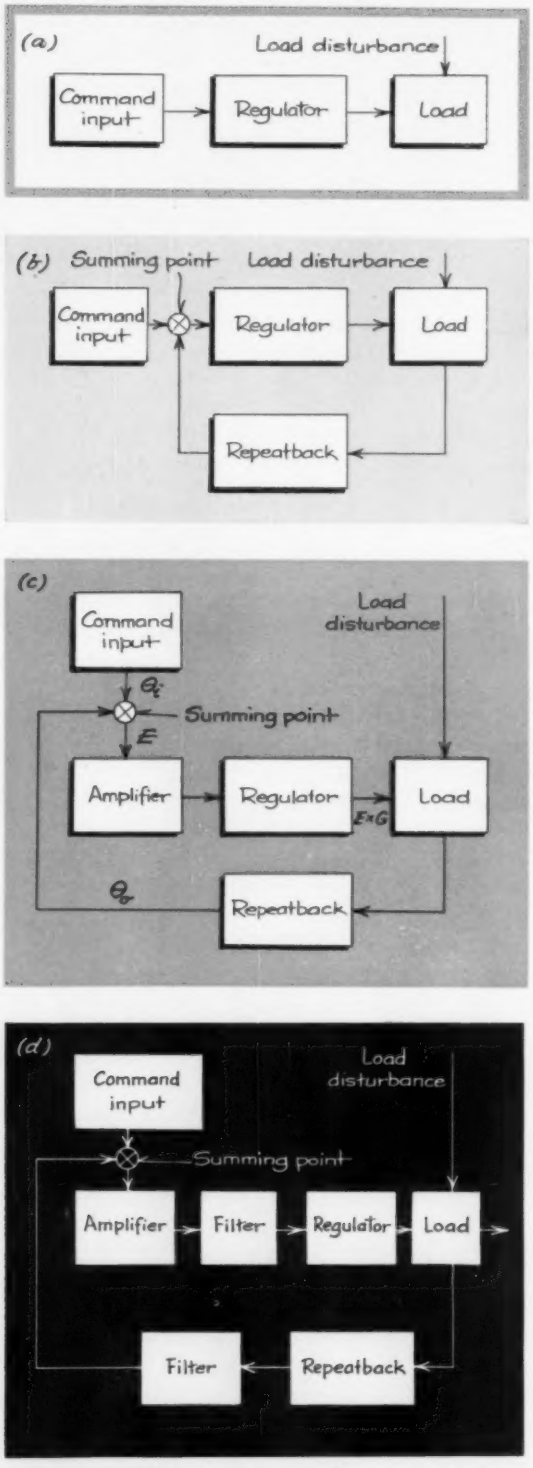


Fig. 1—Simplified block diagrams illustrate the flow paths in elementary control systems: *(a)* Open loop *(b)* Closed loop *(c)* Closed loop with amplification to control larger loads *(d)* Closed loop with amplification and with filters to increase stability.

ELEMENTS OF

• BASIC TYPES

By JAMES R. WALKER
Director of Research
Gemco Electric Co.
Detroit, Mich.

MANY MEANS are available to control the power elements which push, pull, heat, cool, or perform other work functions of the myriad required by modern industry. Control means ranging from the simplest manual methods to sophisticated automatic systems are used. These controls can be fundamentally classified as open loop control systems or closed loop control systems. The control system flow diagrams in *Fig.* 1 indicate the basic elements in such systems.

Since there is no output repeatback device in the open loop system, it may be implied, and rightfully so, that the input member does not receive information on what the output member is doing. In the usual process employing this system it is necessary, for acceptable functioning of the system, to preset the input either to give an output large in comparison to possible load disturbances, or to give full regulator output limited only by judiciously and suitably placed system restraints.

Applications of open loop controls preset to give an output large in comparison to possible load disturbances include: 1. Positioning of a hydraulic double-ended ram. 2. A dc motor-driven alternator. 3. Presetting valve position in chemical process control. 4. Saturation level in a saturable reactor heat control for a furnace.

Examples of open loop controls attaining saturation limits by means of positive stops include: 1. Machine tool table positioning. 2. Indexing mechanisms employing adjustable stops. 3. Feed arms employing pneumatic or hydraulic rams. 4. On-off flow valves.

The term "closed loop" for a control system arises from the fact that the flow diagram for such a system closes back upon itself (in the direction of

Modern machines can employ many varieties of automatic control. Considered decision on the type and degree of control for a specific application requires knowledge of the basic types and their general attributes. The author outlines such fundamental information and discusses some of the applications to automated machines.

AUTOMATIC CONTROL

• CHARACTERISTICS • APPLICATIONS

the arrows, *Fig. 1b*). Thus it is implied that the input point to the regulator is always affected by the conditions existing at the output. Accordingly, it is correctly supposed that the degree of regulation achieved in this control system is proportional to the command input of the regulator. If the command input, for example, requires the regulator to position an output shaft, then the positioning will be accomplished with a minimum of error between the command input shaft and the repeated-back position of the output shaft. The extent of this accomplishment is influenced by the mechanics of the regulator, the regulated member, and external factors operating thereon. Further influence may result from the dynamic and static characteristics associated with the regulator.

Examples of systems utilizing a closed loop control means are: 1. Tool feed position control for machine tools. 2. Table position control for machine tools. 3. Azimuth control of work position on machine tools. 4. Vertical and horizontal angular positioning of military gun mounts. 5. Sychronization of one output shaft speed with that of another. 6. Voltage regulation of a generator. 7. Regulation of voltage in a static power source. 8. Potentiometer positioning in computers. 9. Flow control in a chemical process. 10. Temperature control. 11. Lamp intensity control.

A comparison of open and closed loop control system operation indicates the latter to be capable of extremely small dynamic and static error as a result of included feedback loops acting in a manner to compare the output with the input. Although a closed loop control alone is capable of accurate positioning without the use of positive stops or

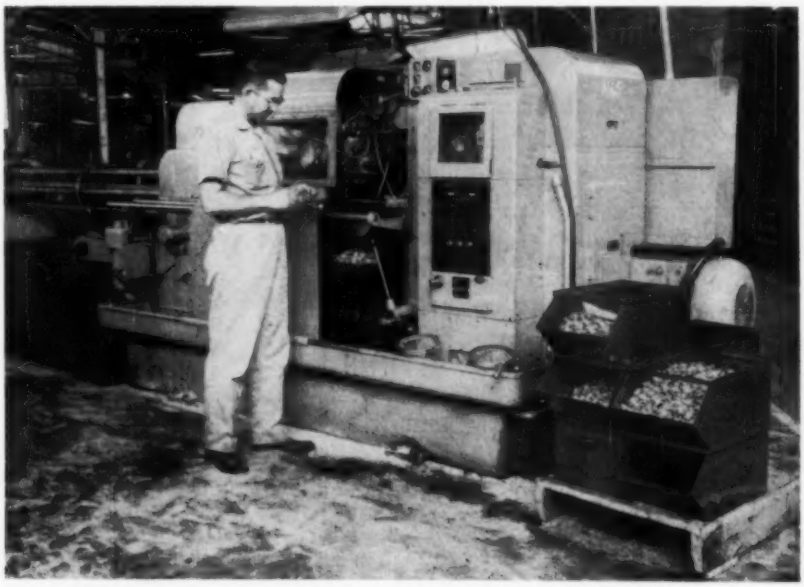
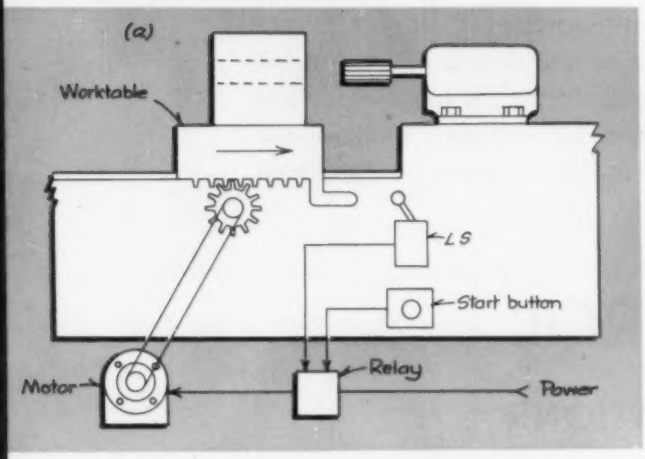


Fig. 2—Six-spindle bar automatic exemplifies the application of automatic control using mechanical control elements. This machine is designed so that an adjustable cam arrangement provides desired tool movements.

Courtesy, Warner & Swasey Co.



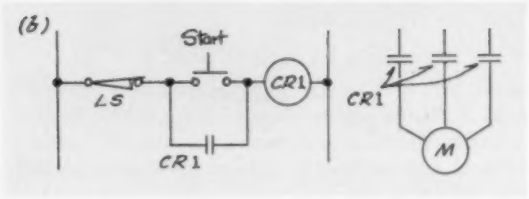


Fig. 3—For an application of simple on-off electrical control to positioning of a worktable, *(a)* shows an elevation view of a machine with worktable to be positioned along horizontal ways, *(b)* shows part of the electrical circuits to control table movement.

manual restraints, it is nevertheless true that certain processes can be accomplished both accurately and effectively with open loop control.

Although employment of a human control element in a given closed loop system can, if the human is alert and dynamically capable of responding to changing disturbance factors, maintain an acceptably low dynamic and static system error, it is not always practical or economically feasible to employ him for this purpose. Suitable regulatory and sensory mechanisms can, during the life of a system, account for their initial cost as well as maintain reliable system control for less expense than that for the human regulator.

▶ Automatic Mechanical Controls

One of the first automatic closed loop regulators employed was the speed governor used with stationary steam engines. A speed set point is established in the regulator by means of a hand-set minimum valve opening corresponding to the engine no-load condition. When engine load is increased, the output shaft speed falls and with this the plane of rotation of the governor fly balls also falls. As a result, the valve is opened further and the engine regains some of its loss in speed. However, the degree of regulation accomplished is dependent upon the power required from the engine for functional operation of the regulator. Since the regulator derives its rotational energy and translational energy from the engine output shaft, a static error will exist between the input or speed set point and the output shaft speed proportional to the power ratio existing between the regulator and engine.

Later versions of control systems have employed command-initiating cams designed to position follower-actuated control arms according to a logical sequence of machine function. Many systems of this nature have employed mechanical command and positioning members with power for positioning members being supplied directly from the cam itself. A minimum amount of electrical control equipment is required with mechanisms of this mechanical type.

Examples of automatic production machinery utilizing sequential cam actuators to both command and position regulating members are:

1. Pantograph operated lathes.
2. Machine tool indexing mechanisms.
3. Automatic screw machines.
4. Coil winding machines.
5. Food wrapping machines.
6. Tobacco wrapping machines.

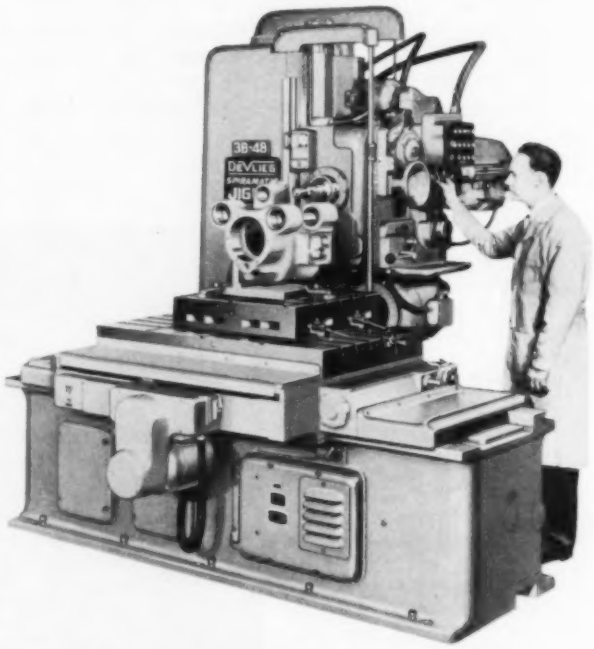
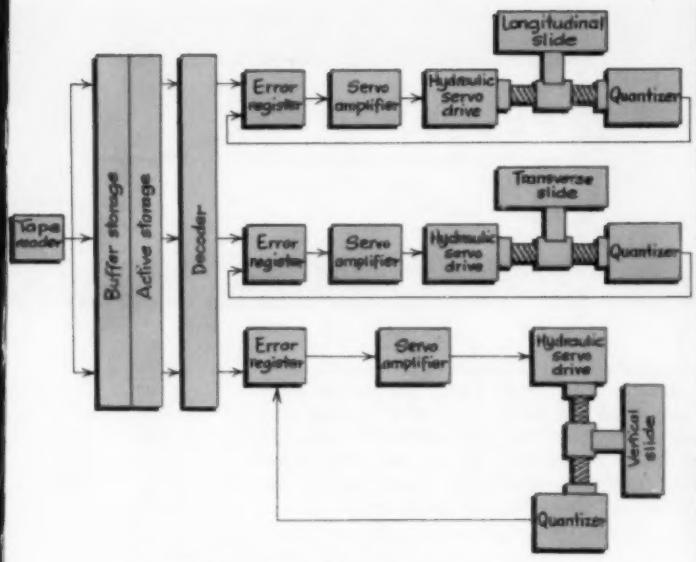


Fig. 4—Boring machine uses a rather complicated control system based on actuation of a limit switch to position the worktable. The table is driven into the limit switch, reversed, driven into the limit switch at a lower speed, reversed again, and stopped. Accuracy of positioning is in ten-thousandth of an inch range.



Courtesy, Bendix Aviation Corp.

Fig. 5—Tape controlled machine applies proportional closed loop control to positioning of work and cutting tool along three axes. Machine (right) is capable of contour milling an intricate shape from a solid block automatically. Diagram of the control system (left) indicates the flow of information from a single tape to control motion along the three axes.

7. Weaving machines.
8. Textile looms.
9. Paper bottle fabricating machines.
10. Paper cutters.

Most of the examples listed are characterized by their independence of command cam and regulator element wear, since these factors only become important when they interfere with the actual assembly or fabrication of the finished component. In the first three examples, it is important to note, however, that command cam and positioning element wear must be minimized and that means are required in the machine to allow compensation for this wear.

One machine tool manufacturer has simplified the cam mechanism normally employed with automatic bar machines, *Fig.* 2, to the extent that only one master cam is required for a given machine to position cutting tools. Adjustment of tool feed stroke is accomplished by means of an easily moved and calibrated variable stroke actuating arm.

▶ On-Off Electrical Controls

Although acceptable machine function can be attained for many manufacturing operations using mechanically actuated control systems, it is necessary in other machine functions to utilize electrical repeatback means for indicating to a command initiator the attainment of desired member positioning. Such closed loop control systems are used in production machinery of various types wherein a command function is initiated by means of a positive acting switch whose actuation results in positioning of a selected member according to motion of its prime mover. Accomplishment of required positioning is determined by the actuation of a limit switch acting to nullify the action of the first switch. Reference to the simple table positioning control for a boring machine, *Fig.* 3, will illustrate this example.

An elaborate electrical control system may be constructed whose complication is determined by the number of prime movers used in the machine and the number of initial steps in each possible function. Further complication results from cross-function and safety interlocks necessary to ensure safety to both operator and machine. Even in the most complicated examples of closed loop system operation employing switches for command input and output repeatback indication, there arises a question concerning the adequacy of system accuracy for many possible uses.

Consideration of this question is dependent upon the magnitude of errors introduced by utilization of positive acting switches for both command and repeatback data, and the effect of machine element dynamics. Relatively large errors are introduced from limit switches exhibiting wide ranges of variability in combination with motor control means incapable of ending table travel at the instant of switch actuation due to inertia of the motor and associated machine table components.

In the face of these inaccuracies in positioning of machine members necessary for various operations, certain quite accurate machines have been developed using such controls. One such machine, *Fig.* 4, is used for boring holes in gear cases, bearing holes in castings and other operations of a similar nature. The control scheme employed with this machine depends for its success on the utilization of

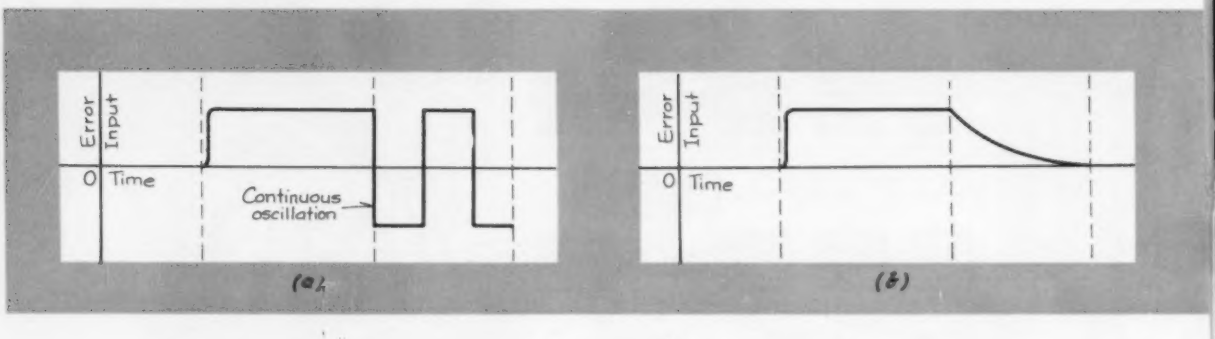


Fig. 6—Graphs depict error conditions in different systems for step-like command inputs: *(a)* On-off servo system which produces continuous oscillation about the control point after error is reduced below maximum output of the servo. *(b)* True proportional servo system in which the error falls asymptotically to a low value after it is reduced below the saturation region. *(c)* and *(d)* Usual proportional servo systems in which values of such factors as inertia and friction determine whether the system will exhibit continuous oscillation *(c)* or damped oscillation *(d)* about the control point.

a limit switch, actuated from a table position marker. Limit switch actuation results in table drive motor reversal following a short overshoot of the position marker due to table and motor inertia. Following reversal of this motor the table is driven in reverse for a selected time interval determined by a timer and then reversed by action of this timer. This time the table is driven at a slower speed into the limit switch in the original direction. Since a lower speed is utilized, the amount of positional overshoot is small following limit switch actuation. Finally, this actuation of the limit switch causes a timed reversal of the table driven motor. This is designed to accomplish a repositioning of the table to reduce the final overshoot as well as to relieve loads on the table drive lead screw.

Choice of suitable time periods for the second and last parts of the cycle yield system position repeatability in the order of 10^{-4} inches. A closed loop proportional servo could not yield greater sys-

CONTROL GLOSSARY

AUTOMATIC—Implied operation without manual effort.

BALANCED AMPLIFIER—An amplifier providing bi-directional output information.

BREAK FREQUENCY—Frequency at which system gain starts to fall.

CARRIER SYSTEM—A control system utilizing control components operating at higher supply frequencies than those in the control band.

CLOSED LOOP CONTROL—System control in which output variable information is repeated back to the input.

COMMAND—An input signal which results in regulation of the output variable.

CONTROL BAND—Region of dynamic error variation.

CONTROLLER—An element which controls a system.

COULOMB DAMPING—Damping obtained from a non-linear reverse force.

CUTOFF FREQUENCY—Frequency at which system gain changes rapidly.

DAMPED OSCILLATION—Oscillation amplitude decreasing with time.

DAMPING—Variation in magnitude of output variable with time.

DAMPING RATIO—Ratio of overshoot gain to dc gain for the system.

DEAD ZONE—Region of no control.

DERIVATIVE NETWORK—A network providing time lead when inserted in a control system.

DISCONTINUOUS CONTROL—Regulator output only intermittently proportional to input.

DYNAMIC ERROR—Difference existing between the command input and output variable in transient state.

FEEDBACK (Negative)—A portion of system ouput fed back to the input in a destructive sense.

FEEDBACK (Positive)—A portion of system output fed back to the input in a constructive sense.

FEEDBACK RATIO—Percentage of output variable fed back to the system input.

FORCING FUNCTION—An input whose magnitude is sufficiently great to change system response.

FRICTIONAL DAMPING—Damping of oscillation achieved by application of a steady reverse force to the regulated member.

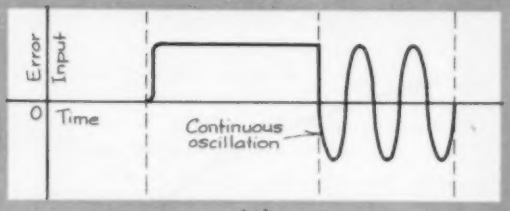
GAIN—Increase in output over input variable.

HUNTING—Oscillation.

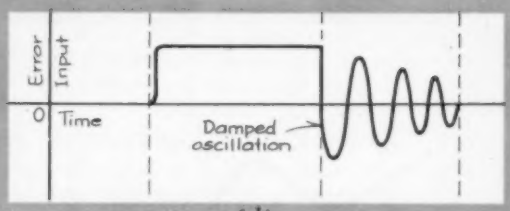
INSTABILITY—Variation in output which is independent of input variable.

INTEGRAL NETWORK—A network providing time lag when inserted in a control system.

LAG TIME—Time required for a system variable to attain its steady state value.



(c)



(d)

tem accuracy. However, it must be pointed out that the principal disadvantage with this combination of relay and limit switch control elements is that it is not readily converted to automatic system operation by utilizing command instructions from punch card, tape, or other memory storage means.

▶ Proportional Controls

Automatic operation can be accomplished by utilization of a proportional closed loop control system rather than an on-off system of the type just discussed. The difference between these two systems can be appreciated from a consideration of the repeatback and command means employed with each. It has been seen that a switch type position repeatback element can only relate to the command switch whether the positioned member has reached its required position, but is incapable of relating whether this member is directly "on" position or "x" feet beyond as a result of system inertia. Proportional repeatback elements employed in a proportional control version of the system just discussed will indicate the exact location of a positioned member with regard to its command position. If a regulator is utilized in conjunction with proportional repeatback and command elements, it is possible to obtain positioning of the regulated element necessary to diminish error differences existing between these elements to a magnitude limited only by allowable amplification of the system. In this example the static error of 10^{-4} inches is the same for both systems.

The block diagram in *Fig.* 1c includes necessary components for a generalized closed loop system.

LOAD DISTURBANCE—An input factor which varies the servo output from that value given by the regulator.

MARGINAL STABILITY—System only stable under certain conditions.

NATURAL FREQUENCY—Maximum gain point of system where oscillation is self-sustained.

ON-OFF CONTROL—System control in which a regulator moves from one of two fixed positions to the other.

OPEN LOOP CONTROL—System control in which no output variable information is repeated back to the input.

OSCILLATION—System undergoing a regular variation in output with no input present.

OVERDAMPED—Steady state achieved with large static error.

POWER CONVERTER—A device for converting power as from mechanical to electrical form, or vice versa.

PROPORTIONAL CONTROL—Regulator output proportional to the input.

PULSE INPUT—A uniformly increasing input.

RANDOM NOISE—Disturbances arising due to internal component variations.

REFERENCE UNIT—A unit which provides a standard unit of reference for a system variable.

REGULATOR—An element contributing to a variation in system output.

REPEATBACK ELEMENT—An element providing signal linearly proportional to output variable.

RESPONSE—Ability of system to reproduce input data.

SATURATION—An unchanging region.

SERVOMECHANISM—A combination of mechanical and other control components arranged to respond to a master or command signal.

SET POINT—Magnitude of ouput variable to be maintained.

SETTLING TIME—Time required to achieve steady state after application of a control impulse.

SINUSOIDAL INPUT—An input represented by a sine wave.

SLAVE CONTROL—A system directed to follow precisely the command of another.

STATIC ERROR—Steady state difference between input and output variables.

STEADY STATE—Conditions of system repose.

SUMMING POINT—A point where control phenomena are combined.

TORQUE TO INERTIA RATIO—Ratio of developed regulator torque to regulator inertia.

TRANSFER FUNCTION—A mathematical relationship expressing the proportional nature of the control system.

TRANSIENT—Variation during a change of state.

UNDERDAMPED—Steady state achieved after several cycles of oscillation.

VELOCITY ERROR—Maximum error achieved during servo tracking of an error signal.

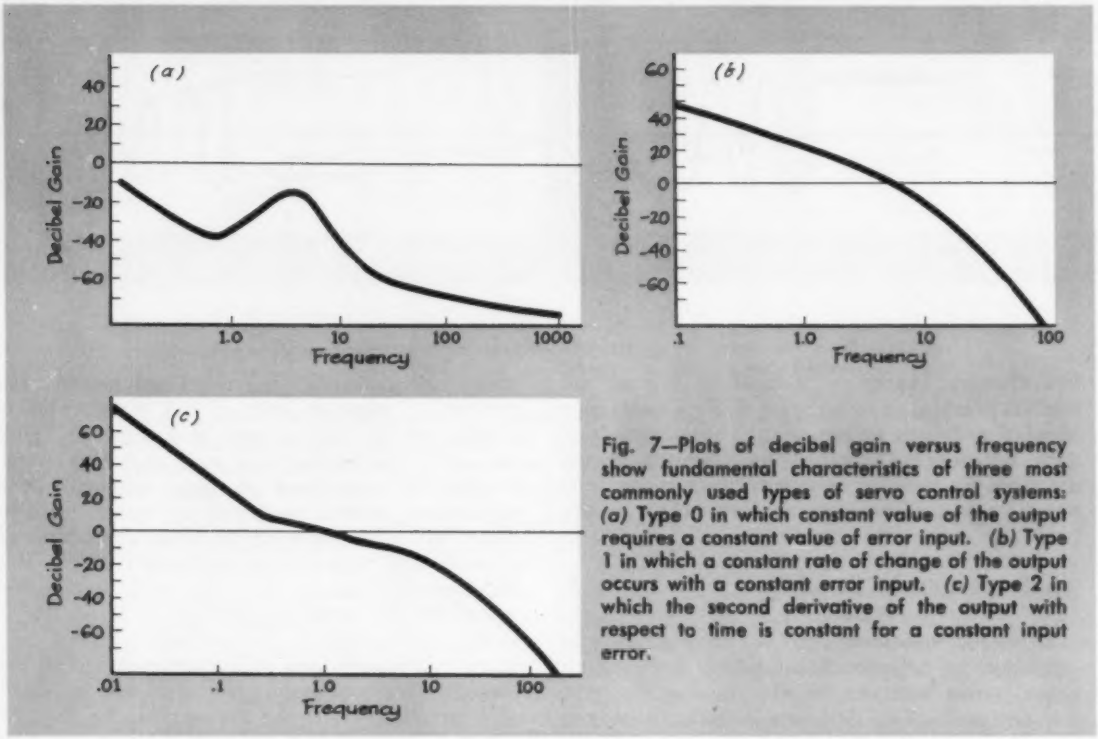


Fig. 7—Plots of decibel gain versus frequency show fundamental characteristics of three most commonly used types of servo control systems: *(a)* Type 0 in which constant value of the output requires a constant value of error input. *(b)* Type 1 in which a constant rate of change of the output occurs with a constant error input. *(c)* Type 2 in which the second derivative of the output with respect to time is constant for a constant input error.

This differs from the diagram of *Fig.* 1*b* in that a gain component or amplifier is employed. This necessity exists because the elements employed for position repeatback in the general case are not usually capable of supplying and controlling directly the regulator element power. Hence a means of power amplification must be used in the closed loop.

The principles involved in closed loop positioning of the worktable for a machine of the type just discussed have been extended to provide an even more sophisticated automatic control function in a three axis milling machine shown in *Fig.* 5. The sequence of operations comprising the control function for this machine can be appreciated from a study of the system block diagram given in *Fig.* 5. This is of the general type illustrated in *Fig.* 1c.

Dimensional information, obtained from a processing sheet for the required component, is placed on a process tape in the form of an identifiable sequence of punched holes. A photoelectric tape reader senses the holes in the tape. One block of information from the control tape is received by an electronic buffer unit where it is stored. An active storage unit receives information from the buffer storage and supplies it to a decoder unit as it is required. The coded digital information from the tape is changed into command pulses by means of a decoder. Each pulse commands an increment of travel in one of the machine's three degrees of freedom. The pulses then serve as input data to each of the servo amplifiers required to energize each machine lead screw hydraulic motor.

Repeatback data quantizers, driven by each machine lead screw, provide information regarding the degree of rotation of each screw. This data is in the form of pulses, each of which corresponds to the same amount of screw travel as a command pulse.

Input error registers are employed to keep a running count of the difference between the number of command pulses and the number of feedback pulses. The resulting error count is converted to a proportional voltage which is received and amplified by each servo amplifier. A hydraulic valve, driven by a servo amplifier in each of the three channels, is used to control the speed and direction of rotation of a hydraulic motor for each degree of freedom in the machine. Each hydraulic motor positions its lead-screw actuated slide in accordance with the digital error existing at its input in such a direction as to minimize this error. Control systems of this nature have been used principally for three-dimensional milling and profiling, hence find somewhat less general application than the boring machine system previously described. In some instances the allowable error in a three-dimensional pattern is greater than that allowable with a boring machine or lathe.

▶ Closed Loop Accuracies

In order that the positioning accuracy of an on-off servo system can be compared with that of a pro-

portional servo system, it is necessary to compare them on the basis of response to similar command inputs. Application of a step-like input or command in each servo system will cause positioning of the regulator motor in a direction to reduce the initial input error to a minimum. Since the leading edge of the curve for this command signal plotted against time is essentially instantaneous-rising for both, it follows that the regulator motors in both systems will operate at maximum speed in order to minimize the instantaneous error. Consequently each servo will proceed to position its load member at maximum speed until the repeatback element, in combination with the command element, indicates a reduction in differential between the two. What then amounts to a differential for the proportional servo is either an open circuit or the making of a reversing contact for the on-off servo.

Fig. 6 illustrates dynamic error conditions existing for the systems being compared. Here the error input to the proportional servo is in the saturation region for a period of time, then falls asymptotically to a very low value. In contrast, the on-off servo enters a region of instability as the repeatback switch is actuated, first to one side then the other. A condition of sustained or continuous oscillation of the on-off servo is shown in *Fig.* 6*a*. This situation can result from utilization of a high performance servo system in which a low gear ratio exists between the regulator drive motor and the regulator load. Under this condition of operation either the motor or load inertia can represent a sufficiently large energy storage element so that the positioned member will always coast beyond the actuating point of the command switch, thus causing a reversal of the regulator in an attempt to obtain a minimum error. Nothing except sustained oscillation is present with this system unless one or both of the following changes are effected: 1. Increase the gear ratio in regulator. 2. Increase frictional damping of regulated member. Either or both of these changes will result in stabilized operation of the on-off servo system, but at the expense of both static and dynamic error.

Consideration of conditions existing in the proportional servo system will disclose that the regulator positioning motor gradually witnesses a reduction in its terminal stimulus directly proportional (below the saturation level) to error signal. If a true servomotor (in which rpm is linearly proportional to driving stimulus) is employed in a proportional system, then its speed will reduce toward zero as the error also approaches zero, *Fig.* 6*b*. Because of this gradual reduction in speed of the motor as it positions the regulated element toward zero error position, it is quite possible that no instability or overshoot beyond the zero point will occur. However, if the motor rotor or regulated element have sufficiently high inertias, a low gear ratio is employed in the regulator, and no damping in the form of friction exists in the regulated element, a continuous oscillation will exist as shown in *Fig.* 6*c*. *Fig.* 6*d* illustrates the damped oscillation of a system including damping such as friction. Further, the existence of a high system power amplification can also account for the same type of instability. In order to achieve stabilized operation with an unstable proportional servo, it is then necessary to accomplish at least one of the following changes: 1. Increase regulator gear ratio. 2. Reduce system power amplification. 3. Increase frictional damping on regulated member. 4. Reduce inertia of regulator and/or load member.

For dynamic error minimization it is necessary to maintain a low gear ratio, hence one of the other changes should be made in order to achieve stability. A reduction in power amplification is undesirable due to the resulting increase in static or "standoff" error achieved under stable operating conditions for the servo. An increase in frictional damping for the system also causes an increase in static error and as a result exhibits the same effect as a reduction in system power gain.

If it is possible to diminish the inertia of both regulator and regulated load without making the other changes, then a reduction in dynamic and static error with increased stability for the regulator can be accomplished. Thus a high performance servo exhibiting a proportional error reduction is possible.

It is often necessary to employ on-off type regulator or servo systems in applications where it is not economically permissible to utilize a proportional servo. In these cases the attainment of stabilized on-off operation by expenditure of power through frictional damping yields an acceptable system even though the exhibited static error is large. It is quite apparent therefore that a high performance, high accuracy system must employ a more complicated and more expensive proportional servo control system. A typical group of applications can be listed for each type of closed loop system, TABLE 1.

TABLE 1—Typical Applications

ON-OFF SERVO SYSTEMS

Operation of Valves
Operation of Camera Iris
Simple Range Computers for Cameras
Milling Cutter Positioning from Master Patterns
Grinding Wheel Dresser Control
Liquid Level Control

PROPORTIONAL SERVO SYSTEMS

Machine Tool Table Positioning
Gun Laying
Proportional Valve Control
Aircraft Autopilot
Mathematical Computers
Speed Controllers
Voltage Regulators
Remote Controls
Synchronizing Processes

TABLE 2—Typical Characteristics of Repeatback Elements

Element	Actuation Force	Max Output Power Level	Output Impedance	Useful Life	Size
Limit Switch	6 oz	1500 watts	0.076 ohms	10^7 cycles	1" x 1" x 2"
Linear Transformer	0.01 oz	10^{-3} watts	500 "	∞	1" dia x 2"
Synchro	0.001 oz-in.	10^{-3} watts	1000 "	10^8 cycles	2" dia x 2½"
Potentiometer	0.05 oz-in.	0.1 watts	500 "	10^6 cycles	2" dia x 2½"
Strain Gage	1 pound	10^{-6} watts	120 "	10^6 cycles	⅛" x ⅓" x 1½"
"E" Transformer	0.003 oz	10^{-3} watts	230 "	∞	1" x 1¼" x 2"

▶ Quantitative Representation

Reference to the closed loop feedback system shown in *Fig.* 1c will allow verification of the fact that an input command angle, Θ_i, in combination with a regulator actuated output angle, Θ_o, will yield an error, E, so that

$$\Theta_i - \Theta_o = E \quad \ldots\ldots (1)$$

and if the amplifier plus regulator gain is G,

$$\Theta_o = G \times E \quad \ldots\ldots (2)$$

A useful relationship can be obtained from a combination of these two simple expressions,

$$E = \frac{\Theta_o}{G}$$

$$\Theta_i - \Theta_o = \frac{\Theta_o}{G}$$

$$\Theta_o = \frac{\Theta_i}{\left(1 + \frac{1}{G}\right)} \quad \ldots\ldots (3)$$

From Equation (3) the angle of rotation of the output shaft, Θ_o, is approximately equal to the input angle, Θ_i, if the gain factor, G, is large in comparison with unity. Thus a previous statement concerning the accuracy of positioning obtained from a closed loop proportional control system is qualified. Extension of these simple quantitative relationships to include reactive type regulator load members, whether they are of a mechanical or electrical nature, is accomplished by a closer study of the proportionality or transfer function relating the two variables of command input and regulated output.

Conditions contributing to reactive instability in regulator or servo control systems are: a. Accumulative lag of amplifier in combination with high inertia load members. b. Accumulative lag of amplifier with multiple lags in load members. c. Lag of amplifier in combination with a highly elastic load transmission and high inertia load. Each of these conditions is quite easily represented in a quantitative manner by methods of servo analysis given in detail by several well-known authors.[1, 2, 3] However,

References are tabulated at end of article.

TABLE 3—Typical Characteristics

Element	Max. Torque	Max. Output Speed
Polyphase Induction Motor	3.3 lb-in.	1800 rpm
Pneumatic Ram	250 lb	3 in/sec
Hydraulic Ram	1000 lb	210 in/sec
Ward-Leonard Control	3.3 lb-in.	1800 rpm
Motor Clutch	3.3 lb-in.	1800 rpm
Amplidyne	3.3 lb-in.	1800 rpm
Thyratron Controlled DC Motor	3.3 lb-in.	1800 rpm

the general form of a transfer function can be given to illustrate various systems encountered in practice.

Since a complete mathematical analysis of an electrical, pneumatic, or hydraulic circuit must involve a study of both steady state and transient conditions of circuit variables, it is necessary to represent these variables in differential form as in a differential equation. Solution of this differential equation will then yield the required transient and steady state values for the variables. They will illustrate faithfully (within the accuracy of estimated or measured circuit constants) the total response of the circuit and associated system.

▶ Control Classifications

A general representation can be given for a system transfer function which can be quite simply specified for any particular case merely by fixing the exponent, n, of the integrating term, P, in the in the denominator to correspond to the classification of control system. Thus

$$G(P) = \frac{K(1 + T_aP)(1 + T_bP)\ldots}{P^n(1 + T_1P)(1 + T_2P)(1 + T_3P)\ldots} \quad \ldots\ldots (4)$$

where $G(P)$ is the open loop proportionality or transfer function,

P is the time operator,

K is the over-all gain of the system,

T_a, T_b . . . T_1, T_2 . . . are time constants of system control elements.

The principal control systems employed are those in which n equals 0, 1, or 2. For the case n equals 0, a constant value of the regulated variable is obtained from a constant value of the error input. Examples of this type are motor speed control systems, voltage regulator systems, and temperature control systems.

When the exponent n is equal to unity in the general transfer function, a constant rate of change of regulated output occurs with a constant error input. Examples of this type servo are found in positioning systems employing electrical, pneumatic, or hydraulic regulating elements.

Control systems with n equal to 2 exhibit a constant second derivative of the regulated output with respect to time for a constant input error. Servos of this type employ secondary position control by a low-power servo controlling a higher-powered servo or a low-excitation hydraulic valve controlling a higher-excitation valve.

It then follows that for each of these types Equation (4) becomes in the general case,

Type 0

$$G_0P = \frac{K(1 + T_aP)(1 + T_bP)\ldots}{(1 + T_1P)(1 + T_2P)(1 + T_3P)\ldots}$$

Type 1

$$G_1(P) = \frac{K(1 + T_aP)(1 + T_bP)\ldots}{P(1 + T_1P)(1 + T_2P)(1 + T_3P)\ldots}$$

Type 2

$$G_2(P) = \frac{K(1 + T_aP)(1 + T_bP)\ldots}{P^2(1 + T_1P)(1 + T_2P)(1 + T_3P)\ldots}$$

A study of the behavior for each type of transfer function, characteristic of a given control system, will allow a close prediction of actual system dynamic behavior. This study is principally concerned with the behavior of each transfer function as the time operator, P, assumes all values from zero to infinity.

Most servo designers and manufacturers of servo control equipment utilize graphical representations of transfer functions of the type shown in *Fig.* 7 for study and representation of both the servo system and its components. A certain possibility of instability exists where decibel gain is greater than zero. Physically this situation amounts to a "peaking up" or resonance of the control system at its natural frequency as determined by system components. Much of the design work accomplished by servo and control engineers is concerned with eliminating entirely, or at best secondarily, the attenuation of the system resonance peak and its removal to a frequency which is no longer contributable to system instability.

Principal among the means available to the system designer for this purpose is the use of filters in either the forward or reverse loops of the system, or both, as shown in *Fig.* 1*d*. It is the purpose of these filters to provide attenuation at system resonance frequencies so that stability may be achieved

of Regulating Elements

Max. Control Power	Useful Life	Size
830 watts	50,000 hrs	8″ dia x 10″
2 watts	72,000 cycles	2″ dia x 8″
0.5 watts	40,000 cycles	1″ dia x 8″
8 watts	30,000 hrs	8″ dia x 30″
80 watts	47,000 hrs	8″ dia x 20″
7 watts	30,000 hrs	8″ dia x 26″
875 watts	30,000 hrs	8″ dia x 12″

TABLE 4—Representative Regulation Accuracies of Various Control Systems

Applications	Control System	Qv	Load Member	Command Input	Static Error	Approximate System Cost
Weighout scales	Pickoff Switch	—	Scale Indicator	10 deg	1 deg	$80
	Induction Pickoff	110,000	Scale Indicator	10 deg	0.1 deg	$1000
Worktable Positioning	Switches and Relays	—	Boring Machine Table	1.1615 in.	0.0001 in.	$1500
	Proportional Servo	220,000	Boring Machine Table	1.1615 in.	0.0001 in.	$7500
DC Motor speed Control	Open Loop	—	Grinding Wheel	1200 rpm	300 rpm	$80
	Closed Loop	2000	Grinding Wheel	1200 rpm	12 rpm	$600
Furnace Control	Thermostat and Relay	—	Furnace	1800 F	100 F	$110
	Reactors and Resistance Bulb	2500	Furnace	1800 F	18 F	$320

without resorting to the expensive necessity of reducing system component inertia and adding frictional damping.

Selection Factors

A study of the data listed in TABLE 2 will allow a comparison of various types of repeatback elements. Worthy of note is the fact that switch type repeatback components are capable of controlling large power in comparison with other types, however, in a non-proportional manner. Position repeatback components other than switches must necessarily employ amplification means to raise their inherently low power level to that necessary for regulator control.

The data of TABLE 3 represent the power requirements for several types of regulators. A comparison of data in both tables indicates the amplification requirements necessary for most repeatback elements are minimized when used with intermediate power regulators, such as: Ward-Leonard generators, amplidyne generators, proportional hydraulic valves, and proportional pneumatic valves.

In each case the actual high power element obtains its principal power component from rotation energy of a driving motor, or a combination of motor and pump. Amplification necessary with these regulator means is low in comparison with that required in double field reversible dc motors, for example, which may be used in conjunction with thyratrons and magnetic amplifiers, or polyphase motors used in conjunction with magnetic amplifiers.

A review and consideration of system component requirements for on-off and proportional closed loop servo systems leads to the conclusion that the former represents the most simple and inexpensive system. But it is generally incapable of exhibiting the positional accuracy obtainable with the latter except with some added complication. Furthermore, it is incapable of being used in completely automatic systems deriving their command data from available digitizers.

Applications not requiring high and repeatable accuracy can employ positive position stops or limit switches to attain required command positioning. Quite naturally the cost and complexity of necessary control equipment is smaller than for proportional control systems.

Yet other applications require a somewhat greater accuracy achievable more expensively by the use of a closed loop on-off control system. Significant, however, is the fact that stability therein is achievable with some sacrifice of static and dynamic response.

It has been shown that proportional type of control would be preferable for applications requiring minimum values of both static and dynamic error, with cost being a secondary factor.

A comparison of regulation accuracy for open and closed loop systems can be gained from a consideration of the data shown in TABLE 4. The cost of this regulation accuracy can also be compared for the systems shown in the same table.

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are you stuck?

In the past few years AUTOMATION has helped in the solution of hundreds of widely diversified practical problems in making operations more automatic. Regardless of the character of the operation or system being developed, somewhere in industry a similar problem has been solved and, very often, equipment is available or suitable techniques are known.

Development can be simplified, engineering costs reduced, and reliability guaranteed with tried and proved equipment and devices available today for achieving successful automation. Whether the problem is simple or complex, practical or technical, the Editors will be pleased to help find the right answer. The vast reservoir of industrial know-how is yours for the asking. Take advantage of this service. Write to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio.

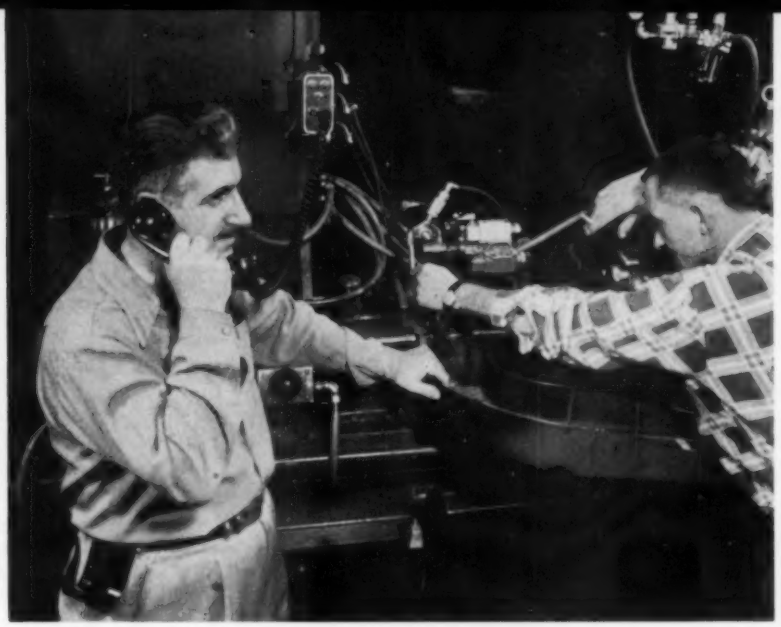


Fig. 1—Each production station is linked to a central dispatch room through a control box into which the foreman in this photo has plugged his portable handset. The foreman can be directed to the machine by the dispatcher over a loudspeaker system. The operator signifies help is needed by flipping an alarm switch which alerts the dispatcher.

ELECTROMECHANICAL SYSTEM AIDS

CENTRALIZED PRODUCTION CONTROL

By **FRED C. JANKE,** Vice President and General Manager, Hancock Mfg. Co., Div., Hancock Industries Inc., Jackson, Mich.

PRODUCTION downtime, such as occurs in almost any manufacturing operation because of machine breakdown or ineffective scheduling, is an expense disliked by management and labor alike. For the company, downtime means no profit in an operation, and, for employees, it means a lower take-home pay, especially where the unproductive rate is less than the productive one.

The stacks of paperwork that accumulate in production plants from the time a customer's purchase order is received until the order is shipped are unwieldy, complex, often duplicated, and expensive to process. All too much of the production supervisor's time is spent in collecting information used by timekeepers or in making out reports—hours worked on different jobs, productive and unproductive hours, number of pieces, etc.

These problems have been attacked at Hancock Mfg. Co., a division of Hancock Industries Inc., by installation of a system being marketed by Control Systems Co., also a division of Hancock Industries Inc. This system links every one of their presses, machine tools, welders, subassembly stations, and other production stations to a central information office. The system provides a continuous communication network between every operator in the plant, his foreman, and the dispatcher; it also acts as a complete registration system of parts produced and time elapsed, virtually avoiding the need for any paperwork in production areas.

Each one of the two hundred production stations is equipped with a control box and a means to sense number of parts, produced, *Fig.* 1. Counting of parts produced may be accomplished in a number of different ways. On most machines, devices such as limit switches, photocells, mechanical gates, or similar means are used to sense rotating or reciprocating motion. The sensor and control box on each machine are linked by electrical cables to a monitor cabinet at the control station or dispatch room, *Fig.* 2. Information for each machine is individually displayed in the dispatch room by grouping twenty machine displays in a separate control cabinet fed from the monitor cabinet.

Fig. 2—In the control room, information is presented for each machine on an individual display panel. Twenty display panels can be mounted on a single control cabinet, and ten control cabinets can be connected to a single monitor cabinet. The monitor cabinet visible back of the operator also contains a 40-pen recording unit for a permanent record of critical operations.

Each machine's control box has a green light, a red light, an *On-Off* alarm switch, a reset button, a key-lock switch, and a communications jack. On a control cabinet in the dispatch office, *Fig.* 3, each machine is represented by a display panel that has a jack for an operator plug, the machine's identification number, clips to hold job ticket information, a green light, a red light, and four counters. The four counters represent the following: 1. Productive time elapsed. 2. Downtime or unproductive time elapsed. 3. Pieces produced within the shift. 4. The number of pieces still needed to complete the order in process.

▶ How It Works

Posting new production orders on the display panels is accomplished on a continuous basis. As soon as one order has been completed, the display's counters showing productive time, downtime, and parts-produced are nulled. Each balance counter is set at the number of parts required for a new order. A new job card is also inserted which indicates that the machine is now ready to be set up. All this information is prepared by the planning department as schedules, handed to the dispatch room daily.

Once the display panel has been prepared, actual machine tooling is co-ordinated between the foreman and the set-up man, but the control system acts as a constant visual display on the productive and unproductive status of each machine in the shop. Another benefit derived from this display system is that dispatchers can readily see which machines need tooling, and which machines have been prepared and are ready to start production at any time.

Before a shift starts, one of the two dispatchers in the dispatch room inserts a numbered operator plug into the display panel of each machine that is to be manned. The number represents the operator's record number, and the plugs are inserted according to personnel assignments made by the foreman. Insertion of this plug closes the panel's electrical circuit; without it, the display will remain inoperative.

The control system starts counting and timing production when the plant master clock energizes the circuit. Wherever an operator's plug is inserted into the panel of a machine ready to run, the green lights on the panel and the control box are illuminated. The dispatcher can see which machines are on productive status, and the operator can see that the machine is supposed to be producing.

As each part is produced, the sensor sends a signal to the display panel in the dispatch room. Two of the counters there record the number of pieces produced and the number required to complete the order. Every 36 seconds a timer in the dispatch room sends a pulse to each of the operating time counters on the display panels. If a machine is on productive status these pulses are recorded on the productive time counter to show in increments of 0.01 hour the productive time spent on that machine. If the machine is on unproductive status, the time pulses are counted by the unproductive time counter.

When a breakdown occurs or the operator requires something, such as more raw material, he operates the alarm switch on his machine's control box. This action causes the red lights on the display panel and control box to flash on and off, accompanied by an auidible beep in the dispatch room. Seeing the red light appear on the display panel, the dispatcher pages the foreman and gives him the number of the machine where help is needed.

Each foreman carries with him a telephone handset which he can plug into the communications jack of a control box. When he reaches the station to which he is directed, he tells the dispatcher what is wrong or what assistance he needs. Whatever help he asks for is directed to him by the dispatcher over the loudspeaker system.

If the problem involves a breakdown, the foreman turns off the alarm switch and transfers the operator from productive time to downtime status by using a

key in the key-lock switch. This action makes the red lights burn constantly, locks the parts produced and balance counters, and switches time pulses from the productive to the unproductive time counter. If the trouble can be fixed right away, the operator will wait to continue production at the same machine. When the machine is ready to resume production, the reset button is pushed and the red light goes off. The green light then signifies a normal situation and productive time status of the machine; the parts produced, balance, and productive time counters are released.

In cases of a more serious stoppage, the foreman tells the dispatcher that the machine is out of production, and he asks for instructions in transferring the operator to another job. Since the dispatcher knows what other production orders must be completed during the shift, he tells the foreman where to transfer the available operator and moves the operator's numbered plug to the display panel representing the new machine.

When a production order has been completed and the number of parts indicated on the balance counter has been reduced to zero, the green lights on the display panel and control box begin to flash. The operator and dispatcher then know that enough parts have been made. The installation of these balance counters alone is said to have saved thousands of dollars per year in avoiding expensive overruns or even more costly underruns. Whenever an operator completes production at one machine, he can be transferred right away to another machine which is ready to commence work.

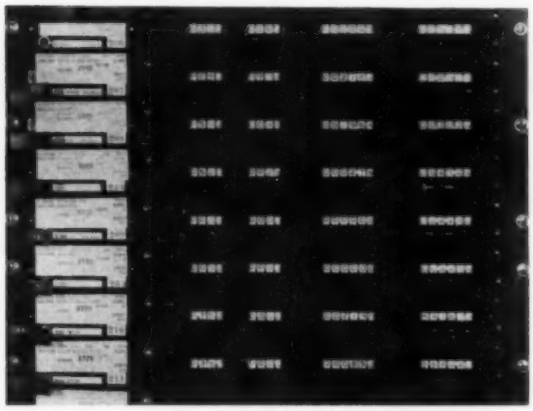


Fig. 3—This view of a control cabinet shows several of the units which display in a single horizontal line the information for one production station. Shown in each display are the numbered plug at left which gives the number of the operator, the machine number and job information, productive and unproductive status signal lights, and four counters which record production statistics.

At the end of each shift the dispatcher reads off the information which has been recorded on each display panel, and he records it on an add-punch machine. These records include machine number, operator number, parts produced, productive and unproductive times, and possibly the balance of parts still to be produced. About a quarter of an hour is required to record this information on a five-channel tape. The information is shown in readily visible form and may be gathered in a number of different ways to suit any data processing system.

The monitor cabinet includes a graphic recorder that gives a permanent record on the operation of as many as forty key operations. This recorder is a forty-pen unit that plots operating cycles of selected machines. The recorder is connected to selected units by setting up the desired connections on a patch panel which is also part of the monitor cabinet.

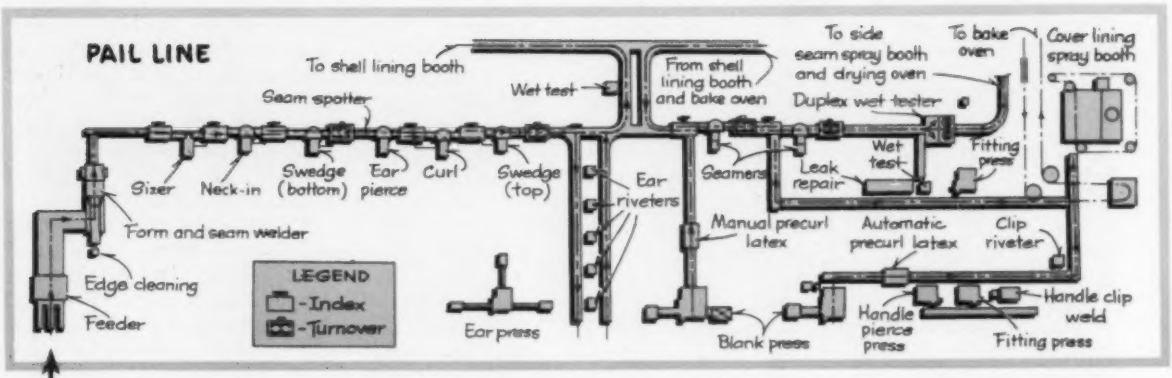
▸ Operating Results

The data recording features of the system have almost entirely eliminated paperwork or other forms of manual record-keeping in production areas. It is estimated that in one year, over $80,000 in nonproductive payroll was saved. Management was able to transfer to other, more productive functions, four foremen, four time-keepers, two checkers, two material handlers, two expediters, one maintenance man, and a payroll clerk. In addition to cutting nonproductive payroll costs, the system made it possible to drastically reduce their unproductive labor costs too. In downtime, $20,000 in one year was converted to useful productive labor since machine operators' efficiencies improved.

A point of note, also, is that in addition to the nonproductive payroll saving and reduction of downtime, other advantages were gained from the changeover to this control system. One is the value of the system to production management in seeing all productive stations within their plant at a glance from one central location—the dispatch room. Another important gain was the increased accuracy of production records.

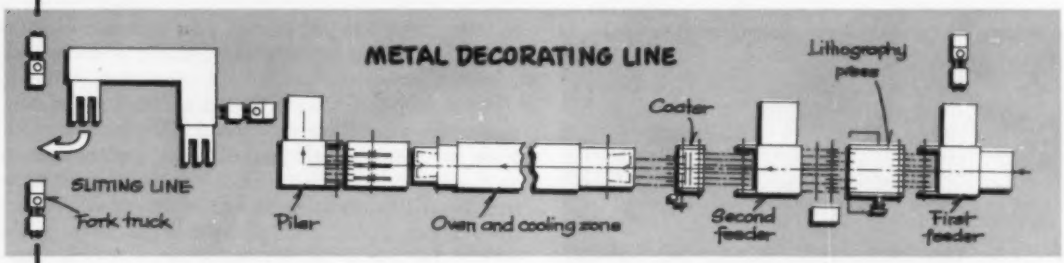
Also, a new production order can be monitored through its initial stages entirely from the dispatch office. From this central vantage, a new part's routing through manufacturing can be plotted accurately and any individual stage can be observed. Should trouble occur anywhere along the line, management is in instant communication with shop supervisors at that particular point and is able to regulate and control parts traffic at other critical points to avoid a possible jam. Production time can be checked for all machines along a new part's route from one central place and cost computations arrived at in much shorter time.

As designed to handle two hundred production stations, this control system costs approximately $50,000, or about $250 per work station. This initial cost seems more than reasonable in view of the fact that the system in one year saved more than its cost in reduction of the indirect labor payroll alone. When other savings, such as reduction of downtime, are considered, the over-all cost of the control system was amortized in considerably less than twelve months.

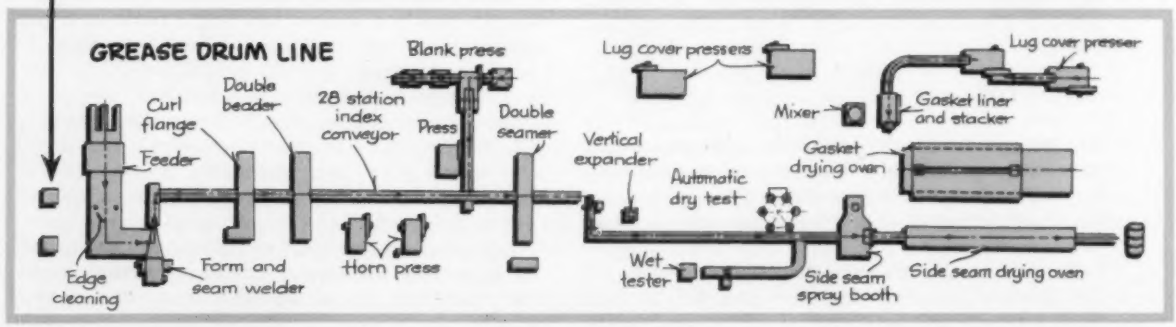


AUTOMATION TODAY

HANDLING



1 Manufacture of grease drums and 5-gallon pails starts on the decorating line where metal sheets are printed with lithographed product labels and/or coated with paint or lacquer for the containers. After drying in an oven, the stacks of decorated sheet metal are delivered to a slitter where the four edges are trimmed, and the sheet is slit into two parts. Handling trucks then deliver the finished sheets to either the automated grease drum fabrication line or the automated pail line. The grease drum line is less complex than the pail line which is equipped to handle a variety of modifications to the basic 5-gallon pail. These include variations in handle, cover, and pouring-hole requirements. Decorating line and slitter operations are shown in the accompanying illustrations.



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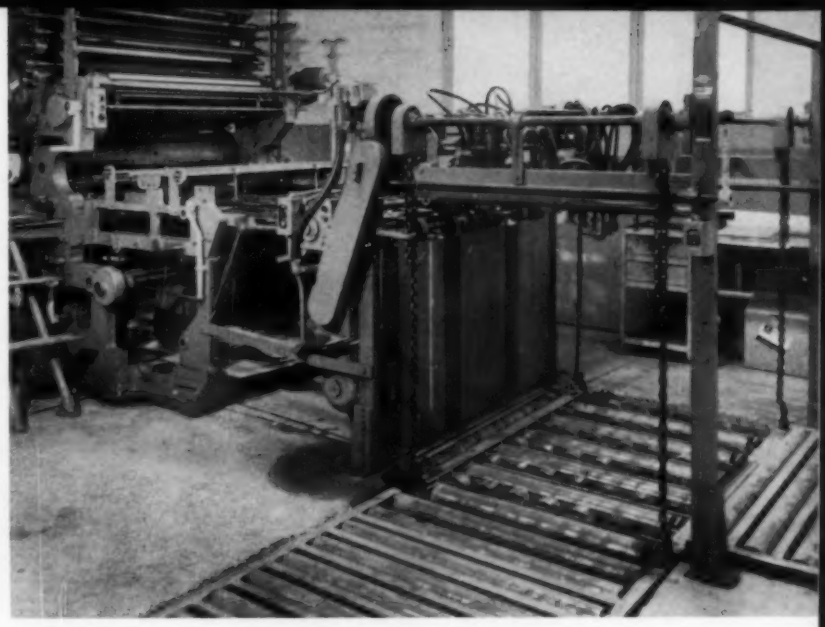


Automated sheet feeder is used to feed metal sheets to the lithograph press at the beginning of the decorating line. Stacks of sheets are brought to the Dexter Co. feeder by fork truck and deposited on either of two standby conveyors which discharge to the feeder elevator platform. The load is raised to the level of the feeding mechanism; a pile height governor automatically indexes the load upward as sheets are fed off. Suction cups lift the top sheet at the rear corners, and a blast of air is blown under the sheet to separate it from the stack. Forward suction cups then lift and pivot the sheet, advancing it between friction rollers for delivery to the lithograph press.

SHEET METAL

ON CONTAINER DECORATING LINE

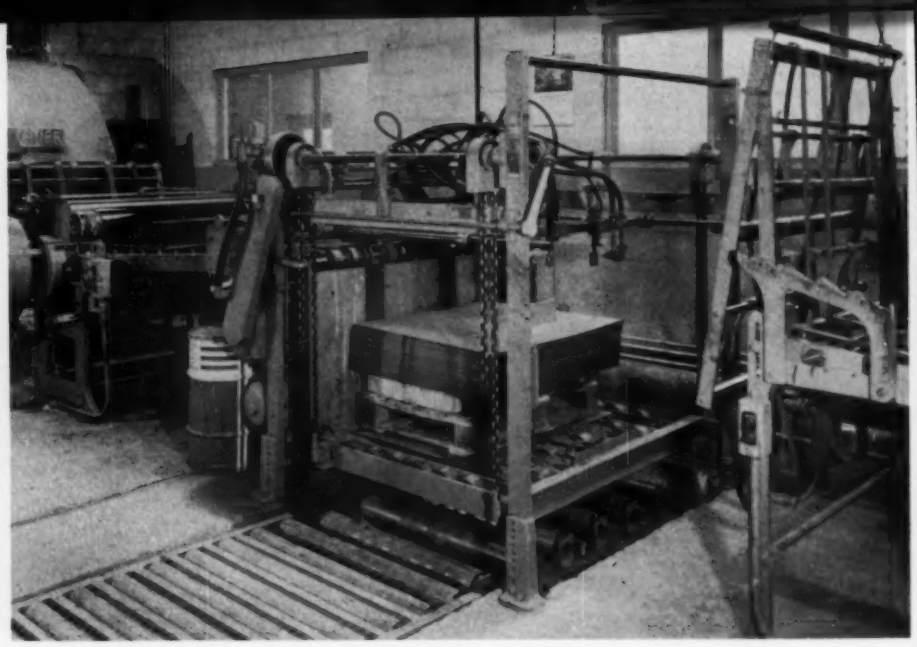
MANUFACTURE of large metal grease drums and 5-gallon grease pails has been automated to a large degree on continuous production lines at a new plant of the U. S. Steel Products Div., U. S. Steel Corp. in Camden, N. J. In operation for approximately one year, the Camden operation is one of the most mechanized of its type in existence.

Prior to being formed and welded into drums and pails on the automated production lines, metal sheets are processed through a metal decorating line which prints and/or coats each sheet. After this operation, the sheets are edge trimmed and slit in two on a metal slitter and then delivered to the separate drum and pail fabricating lines.

The decorating line consists of an automatic sheet feeder supplied by the Dexter Co. which feeds a lithograph press, a second Dexter sheet feeder in-line with the printing press which feeds a coating machine that applies paint or lacquer to the processed sheet, a 120-foot drying oven and cooling zone, a "paddle wheel" device that turns the printed and/or coated sheets over for further decorating operations, and a Dexter piler for stacking the finished sheets. Stacks of metal sheets are brought to the decorating line by fork truck and deposited on floor-level standby conveyors which discharge the stacks to the automatic feeder elevator platforms as required. From this point, decorating operations are continuous and automatic until the finished sheet is piled on the opposite end of the line ready for slitting and trimming.

The in-line arrangement of the lithograph press and the coating machine allows three methods to be used in decorating the sheets. For sheets that require only painting or lacquering without lithographing, stacks of plain sheets are loaded onto the second automatic feeder and are fed directly into the coating machine, drying oven, and final piler. If the plain sheets are to be lithographed only and not coated, they are fed from the first automatic feeder into the lithographic press, and then conveyed across the top of the second feeder on a collapsible conveyor, through the inoperative coater, and into the oven. At times both lithographing and coating are performed on the same sheet, and the collapsible conveyor passes the lithographed sheets to the operating coater and the oven.

The horizontal sheets are upended as they enter the oven and travel through the oven on edge. Inside the oven the vertical sheets are supported by rectangular wire wickets secured to endless conveyor chains. When the sheets leave the oven, they are upside down with their printed faces down in reference to their starting positions. If it is desired to



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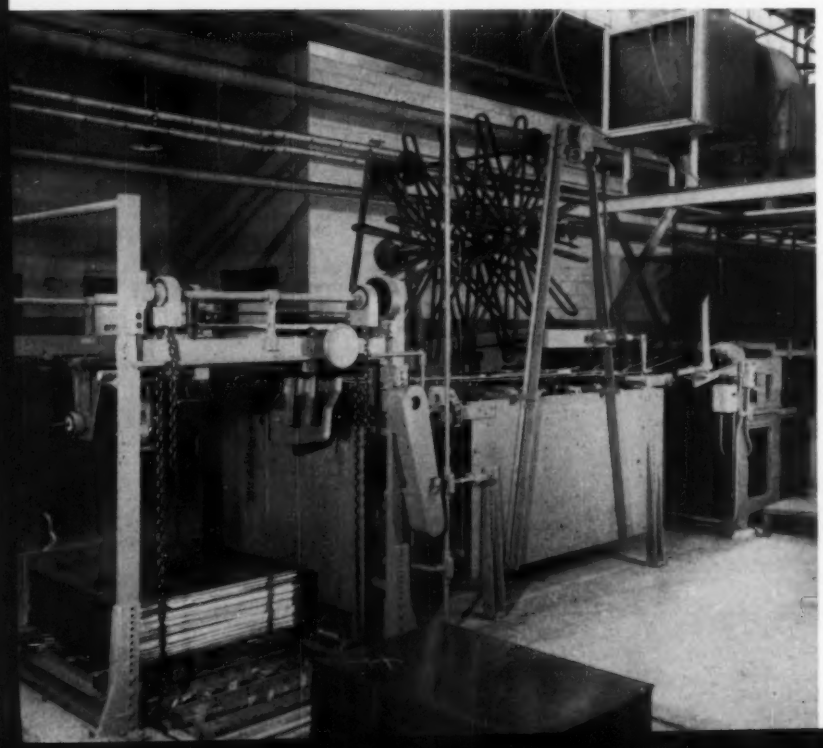
Following the lithograph press is a second automatic feeder which services a coating machine for applying paint or lacquer to the sheet. For sheets that are not lithographed but are coated, handling trucks deliver stacks of sheets to the side loader of the feeder for processing. When sheets are lithographed first, a collapsible conveyor on the right is lowered in position to join the printing press, coater, and oven into a continuous line. The sheets can then be passed through the inoperative second feeder and be coated with paint or lacquer or not coated before entering the oven.

turn the sheets over for further decoration or for subsequent slitting and forming operations, a "paddle wheel" device may be lowered into the line to receive the sheets and flip them over. Otherwise, the turning device remains above the line, and the sheets pass directly to the sheet piler unit.

Following the metal decorating operation, stacks of sheets are delivered by fork truck to the slitter operation where the sheets are edge trimmed and slit in two, separating the designs for two containers applied to each sheet. Trimming and slitting operations must be closely controlled since there must be exact meeting of sheet edges at the automatic welders in the fabricating lines to assure perfect joints. Slit and trimmed sheets are discharged onto specially designed pallets for transfer by fork truck to either the pail or grease drum fabricating lines.

The accompanying photographs show the operations occurring on the sheet metal decorating line and at the slitter. Flow diagrams illustrate the major operations accomplished on the automated grease drum and 5-gallon pail fabricating lines.



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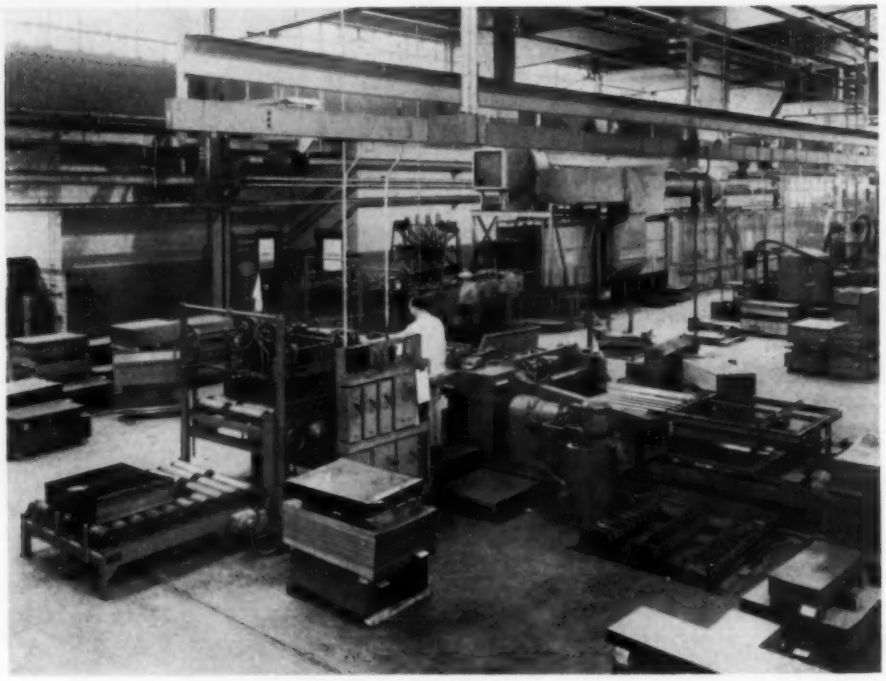
Decorated sheets travel through the 120-foot drying oven and cooling zone in a vertical position supported by rectangular wire wickets. After delivery from the oven conveyor, the sheets are in a horizontal, upside-down position with reference to their starting position. If sheet turnover is required for further decorating or subsequent slitting and fabrication, a "paddle wheel" device is lowered into the line to flip over the sheets. If turnover is not required, the paddle wheel device is by-passed, and the sheets pass directly to the Dexter sheet piler. This unit operates in reverse of the sheet feeder. Stacked sheets are lowered by the elevator unit and deposited on the side conveyor on blocks rather than pallets for delivery by handling truck to the slitter operation.



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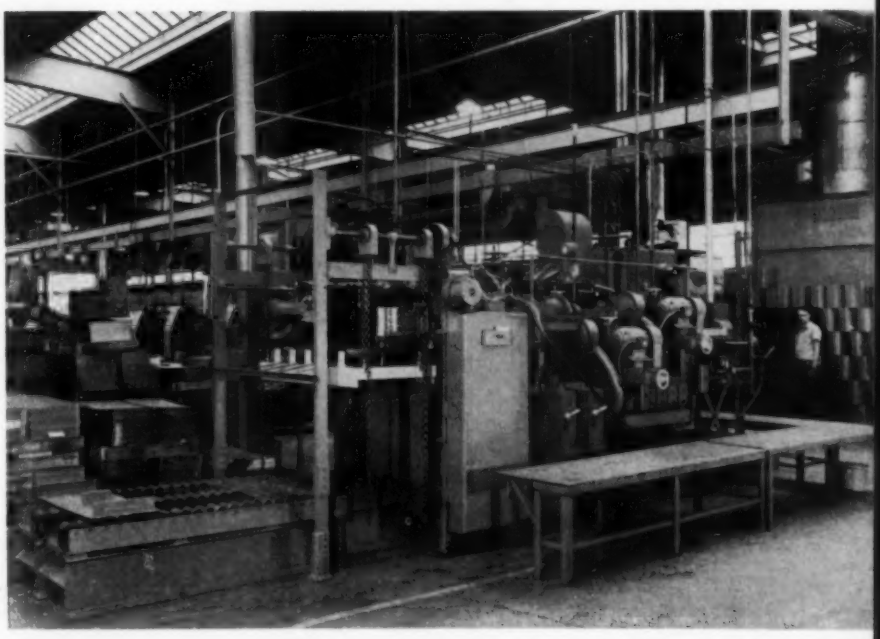
Unpalletized stacks are delivered to the slitter and are deposited on the sectionalized standby conveyor on the left. The operator lowers the feeder elevator platform and actuates the standby conveyor to move the load into the feeder. After trimming two opposite edges of each sheet, the slitter transfers the sheet to the dog-leg on the right where the remaining edges are trimmed, and the sheet is slit into two parts. Finished sheets are then stacked on special metal topless pallets in the piler and ejected onto the standby conveyor for removal by truck to the grease drum or pail fabricating lines.

6

Beginning of the 5-gallon pail fabrication line shows the special topless pallet which facilitates reloading the lines with decorated sheets without stopping the line. When the stack of sheets is depleted to a thickness of less than 2 inches, a "fork" is placed beneath the pile and secured to the feeder frame. Elevator platform is then lowered, the empty pallet removed and replaced with a full pallet, and the platform raised to engage the old stack of sheets. The fork is then removed until the pile needs replenishing. Upon leaving the feeder, the sheets are automatically ground on their edges and are formed and welded automatically into pails as shown on the flow diagram of Fig. 1.



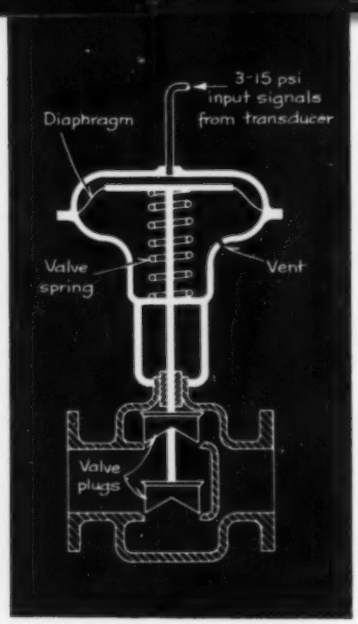
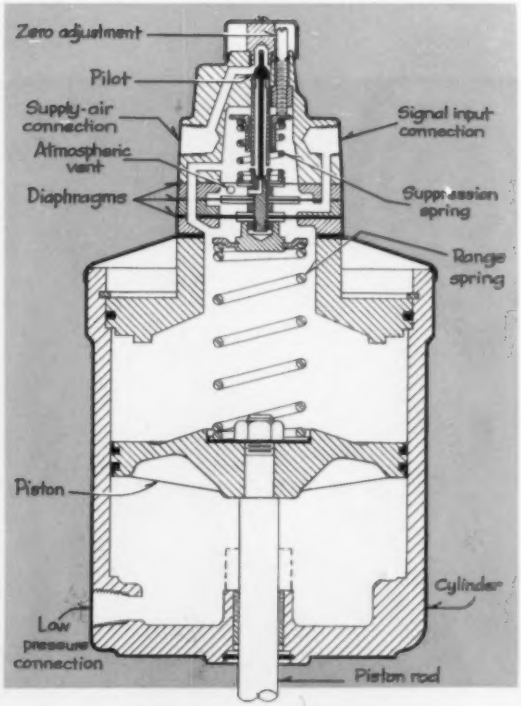


Fig. 1—Pneumatically operated control valve of a type commonly used in process control applications employs spring and diaphragm actuator. Air signals admitted to chamber above diaphragm oppose spring pressure and position valve plugs to control flow through valve.

PNEUMATIC VALVE POSITIONERS

PROVIDE SERVO ACTION

First applied in the process industries to operate valves in response to air input signals, pneumatic valve positioners are becoming recognized for their broader function as pneumatic-mechanical servo devices. As a result, they are finding increased use by many industries for actuation of final control elements in the automatic control of flow, pressure, speed, and electric power.



By JAMES B. MADISON
Conoflow Corp.
Philadelphia, Pa.

PROCESS INDUSTRIES such as those in the chemical and petroleum fields have for many years obtained accurate automatic control of flow through use of pneumatic control loops. A typical loop includes a control valve and an instrument-type transducer that can measure process variables—temperature, pressure, liquid level, etc.—and generate pneumatic signals proportional to the magnitudes of the variables. These signals are piped to the control valve actuator and operate the valve to apply corrective action to the flow.

Fig. 2—Valve positioner, or pneumatic-mechanical servomechanism, effects positioning of piston rod in accordance with air control signals of 3 to 15 psi admitted to input connection. Actuating power is obtained from primary air source and can exceed that obtainable from spring and diaphragm type actuators. Unit is also more compact and has faster response than spring and diaphragm arrangements.

Measuring and transducing devices—sometimes in a single unit but more frequently a combination of separate units—have progressed satisfactorily enough to keep up with demands of the process industries for better units. They are available in very simple forms for prices under $100 and in complex forms capable of measuring, recording, and controlling in a single package for over $1000. Most of these devices use air for both the signal and power, although electrically and hydraulically operated types are available.

In general, air signals varying between 3 and 15 psi are applied to the actuator of a control valve. The actuator is designed to traverse the valve from its fully open to fully closed position or vice versa within the 3 to 15 psi signal range.

A common type of control valve, *Fig.* 1, consists of a spring-and-diaphragm type actuator which operates a specially designed valve. The valve body has two ports, and double valve plugs are used which are balanced so that they tend to negate the effect of line pressure in the valve. Without such an arrangement, high diaphragm loading forces would be required to close the valve against line pressure. The topworks, or actuator, consists of a flexible diaphragm opposed by a spring. Positioning of the valve plugs with respect to the ports is obtained by balancing the compression of the spring against the force of the air signal on the diaphragm.

Such control valves, using diaphragm-type actuators, have served the needs of the process industries for many years. However, recent developments in pneumatic actuators have widened the selection of control valves that can be actuated pneumatically and also have made possible the use of other types of final control elements in pneumatic control loops. Adoption of the pneumatic control loop concept by other industries for control of numerous parameters in addition to flow has resulted.

▶ Pneumatic Valve Positioners

A significant advance in pneumatic control technology has been the development of a device known as a valve positioner. This is a pneumatic relay, or pneumatic-mechanical servomechanism, that obtains actuating power from a primary air supply, while providing proportional positioning in response to 3 to 15 psi air signals. Functionally, the positioner has eliminated the past practice of balancing signal air pressure against a spring to obtain proportional positioning. Instead of a diaphragm motor, use of a pneumatic cylinder with a positioner for proportioning can be considered. The combination of a cylinder and proportioner, in addition to providing high actuating power over long strokes, is compact and capable of high speeds of operation.

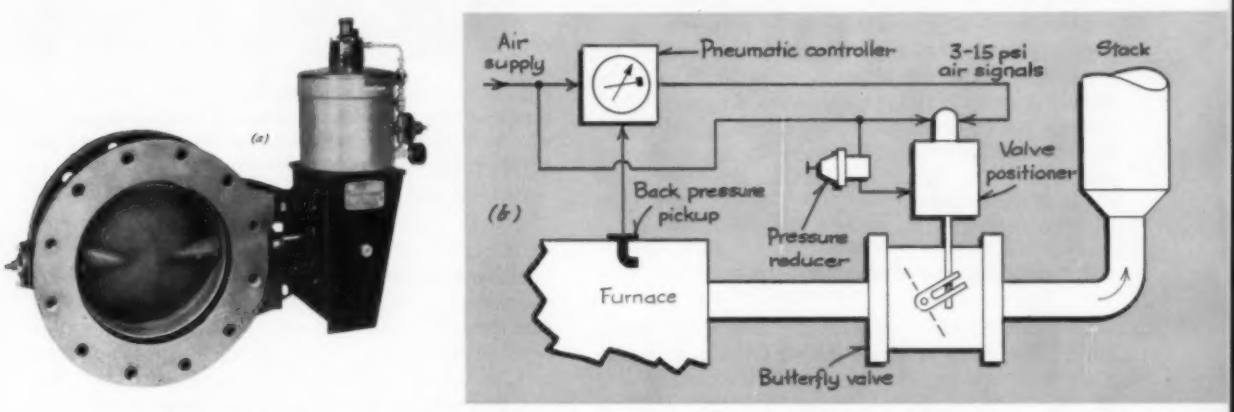


Fig. 3—Butterfly valves *(a)* are among types that can be controlled automatically with valve positioners. Schematic diagram *(b)* shows an application in which a controller measures back pressure in a furnace and adjusts butterfly valve through valve positioner to provide desired draft in stack.

A typical cylinder-positioner combination, *Fig.* 2, accomplishes positioning by applying variable loading to the top side of a piston in accordance with air input signals of 3 to 15 psi. The underside of the piston is statically loaded with a fixed air pressure less than supply.

In operation, the upward force on the piston due to the static load acts on the bottom of the diaphragm assembly in the positioner through a range spring. This force is counterbalanced by downward pressure from a suppression spring. An air signal, applied to the input connection of the positioner, is admitted to a cavity formed by a lower and center diaphragm. Because the center diaphragm has a greater effective area than the lower diaphragm, the air signal causes the diaphragm assembly to rise. This action opens a pilot valve by a related amount, allowing supply air to be admitted to the top side of the piston.

As the piston moves downward, the range spring is relaxed proportionally, reducing the upward force on the diaphragm assembly and allowing the pilot

valve to restrict the flow of air to the top side of the cylinder. When the piston reaches a position called for by the original 3 to 15 psi air signal, only a small pilot flow is admitted to the top side of the cylinder to provide rapid response to changes in signal pressures. If the piston should tend to move downward beyond the selected position a vent will open in the pilot valve and relieve pressure on the top side of the piston. The range spring in this unit provides no power; it is a feedback element connecting the piston to the diaphragm assembly in the positioner.

Valve positioners of this type can provide cylinder strokes up to 8 inches and can be operated with supply pressures as high as 100 psi. Thus, if the static load under the piston is set at 50 psi, and the supply pressure is 100 psi, a theoretical thrust of 2500 pounds can be developed by an 8 inch cylinder having an effective area of 50 square inches, neglecting rod area. This force is available over the entire stroke of the cylinder.

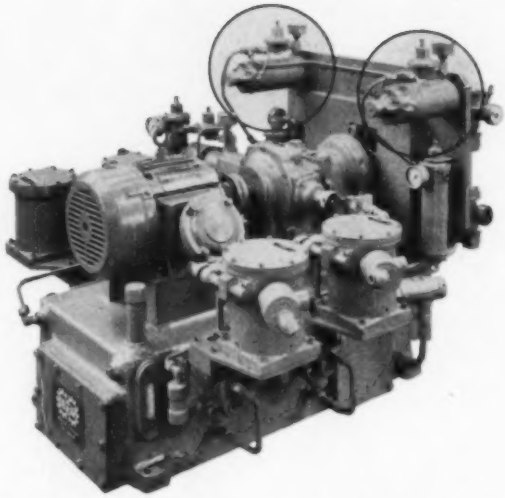


Fig. 5—Two valve positioners are used to control pressure and flow in hydraulic pumping system. Equipment can be installed in hazardous location and controlled remotely by air signals to positioners.

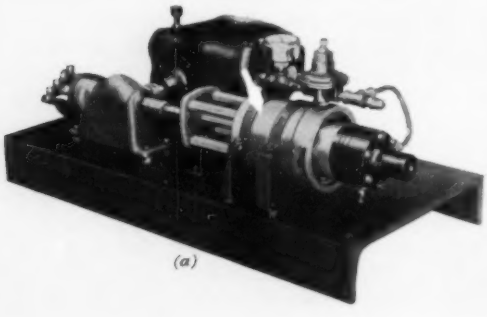
Controlling Valves

One of the earliest uses for this device was to operate valves such as single ported types that require high stem loading to accomplish positioning and shutoff. The process industries have been quick to recognize the economic advantages of going to such valves in certain cases. Butterfly valves, *Fig. 3a*, which are ideal for controlling flow in large pipe lines with low fluid pressures, can now be controlled automatically. They are available in sizes ranging from 4 to 84 inches. A typical control loop including a butterfly valve is shown in *Fig. 3b*. While this type of valve does not provide any better control of flow than a double ported type, it is less expensive in larger sizes. Also, it is probably the only type of valve suitable for line sizes over 16 inches.

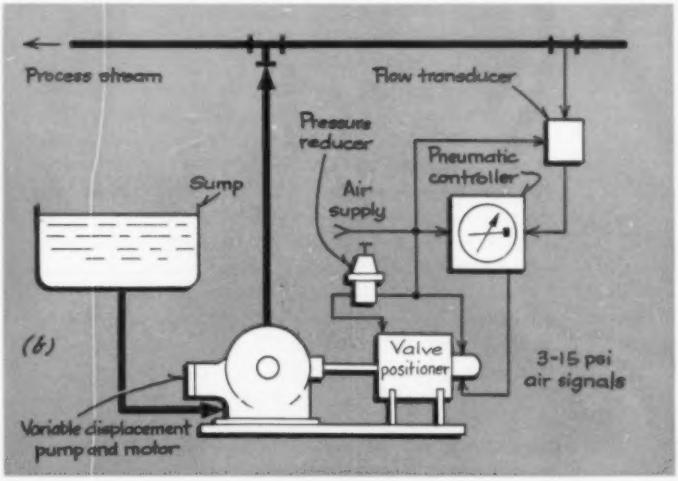
Another widely used valve is known as the Saunders patent valve. Because it is packless, this type of valve is used extensively for the control of flow of corrosive, toxic, explosive, and expensive fluids. It is also desirable for handling slurries and is widely used in the paper, water treatment, sewage disposal, and chemical industries. However, an 8 inch valve of this type may require closing forces against line pressure as high as 7000 pounds. To handle such situations some manufacturers offer pneumatic valve positioners with cylinders as large as 14 inches in diameter.

Other special types of valves can now be considered for automatic control because of the availability

Fig. 4—Piston displacement of a reciprocating metering pump is adjusted by a valve positioner that accepts 3 to 15 psi air signals *(a)*. Pneumatic control loop diagram *(b)* illustrates use of metering pump in a circuit that automatically injects additive to uncontrolled process stream in a predetermined proportion.



(a)



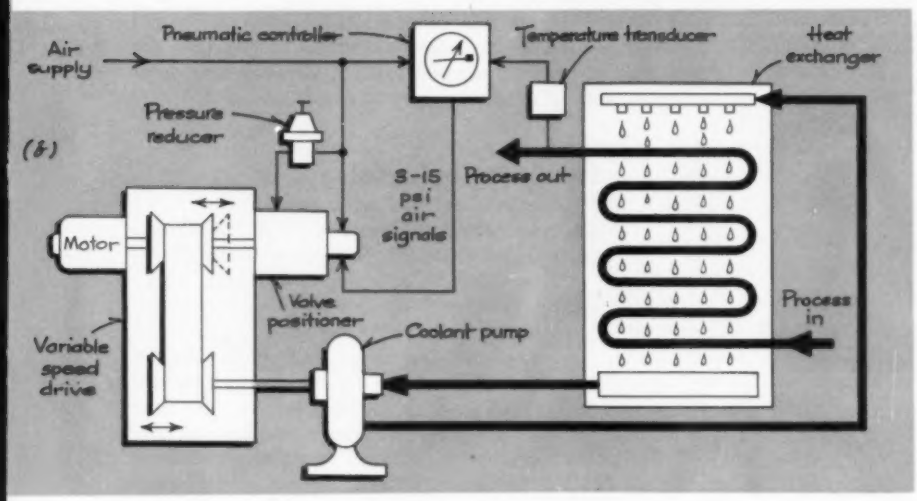


Fig. 6—Valve positioner, operating speed changer in response to air signals from controller, governs speed of fixed displacement coolant pump to control temperature of process stream. Temperature transducer provides feedback signals.

of high-powered valve positioners. One type of valve so actuated is designed for extremely high pressures such as are used in steam reduction and wind tunnel research where both shutoff and throttling control are required. Pressure drops to 2500 psi can be controlled.

Other Final Control Elements

Metering pumps, which have long been used for manual control of process flow, can readily be converted to automatic control through use of transducers and valve positioner actuators. In this service the functioning of valve positioners as pneumatic-mechanical servomechanisms is perhaps more apparent.

In one such arrangement, *Fig. 4a*, a valve positioner controls the piston displacement of a constant-speed reciprocating pump. Flow rate is a function of valve positioner setting, which in turn depends upon the magnitude of the 3 to 15 psi air signal input to the positioner. It is possible to employ linkages or other mechanisms between the positioner and the pump so that different ratios of pump flow rate to magnitude of air signal can be selected.

A typical control loop for a metering pump arrangement is shown in *Fig. 4b*. This arrangement provides proportional flow rates without the expense involved in calibrating control valves. In addition, such control loops are more satisfactory in handling extremely small flows, and provide rangeability not attainable through use of control valves.

Recently, attention has been given to use of valve positioners to control both flow and pressure output of hydraulic pumps. In *Fig. 5*, two small positioners automatically control both the pressure and volume output of a hydraulic pumping system. The equip-

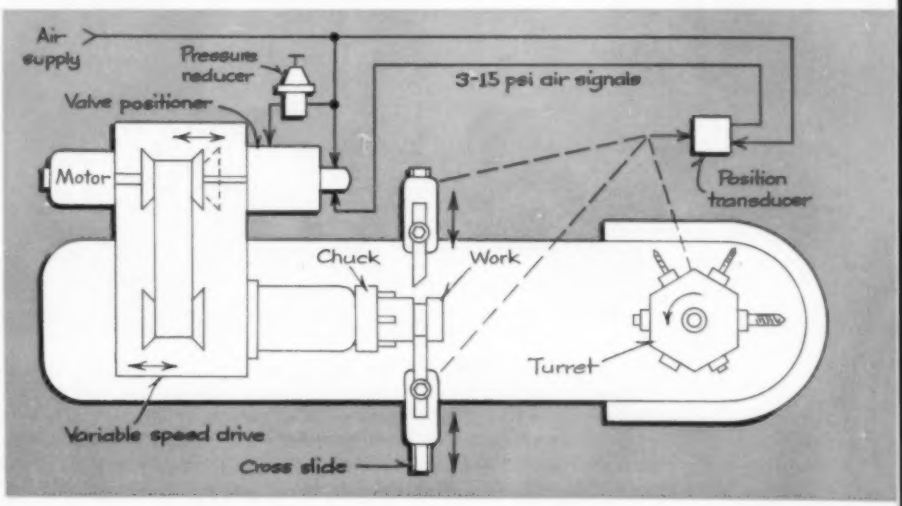


Fig. 7—Schematic plan view of machine tool application that employs valve positioner to control turret lathe spindle speed. Position transducer senses locations of cross slide tools and automatically increases spindle speed as tools advance into work. Optimum discrete spindle speeds are also provided for each of the turret tools by interlocking the turret with the position transducer. Repositioning rates for valve positioner can be as high as 1 inch per second.

ment can be installed in hazardous locations and controlled remotely by air signals.

Automatic Speed Control

In many cases it has been found expedient to control the ouput of a pump by varying its speed. Use of commercial speed changers equipped with valve positioners to effect adjustment is a convenient means of providing automatic speed control. The arrangement diagrammed in *Fig.* 6 illustrates a typical pump control application. Packaged units that include speed changer-positioner combinations are available for chemical pumping equipment.

Pneumatic valve positioners are finding increasing use in machine tool applications involving spindle speed control. A turret lathe application, *Fig.* 7, illustrates control of spindle speed for both turret and cross-slide tools. Infinitely variable speeds during facing and cutoff operations are accomplished through use of a position transducer that automatically increases spindle speed during the in-travel of a cross slide. This provides a constant cutting speed effect that gives a more uniform finish to the work in a shorter time than that possible with constant spindle speed.

Optimum spindle speeds for each of the turret tools are also determined automatically by interlocking the turret with the position transducer. In this case discrete speeds are provided which depend on the turret tool in use. In applications of this type the positioner must respond rapidly. Repositioning rates as high as 1 inch per second can be attained.

Electric Power Control

A packaged unit including a valve positioner and a variable autotransformer is illustrated in *Fig.* 8 along with a diagram of a circuit in which it can be used. A recorder/controller supplies 3 to 15 psi air signals to the valve positioner which in turn rotates the autotransformer input shaft to the desired position. Magnitude of the air signals is a function of the difference, or error, existing between the temperature setting of the recorder/controller and the actual temperature as indicated by a thermocouple in the electric furnace. Voltage output of the autotransformer is a maximum for a cold furnace and is reduced as the furnace temperature approaches the desired value set on the recorder/controller.

There are many other applications for valve positioners used as pneumatic-mechanical servomechanisms. Whenever a knob, handwheel, or other adjusting device is manipulated several times a day, a condition exists that may best be met through use of these devices. This is particularly so if adjustments are made in accordance with information obtained from measuring instruments. Control loops can then be designed that correlate the actions of the instruments and the positioners to provide automatic control. Benefits such as elimination of human error, continuous automatic correction, and remote operation of equipment then become available.

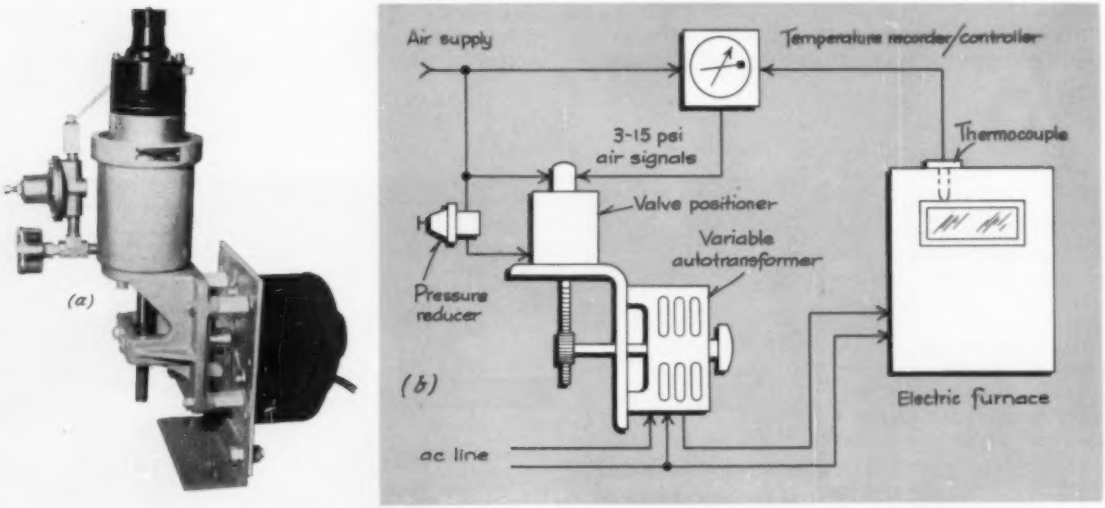


Fig. 8—Packaged unit *(a)* including a valve positioner and a variable autotransformer is used to vary voltage or current in control applications. In *(b)*, a recorder/controller supplies 3 to 15 psi air signals to valve positioner which in turn varies setting of autotransformer to control furnace temperature. Thermocouple monitors furnace temperature and provides electrical feedback signals that modify air signals from recorder/controller according to requirements.

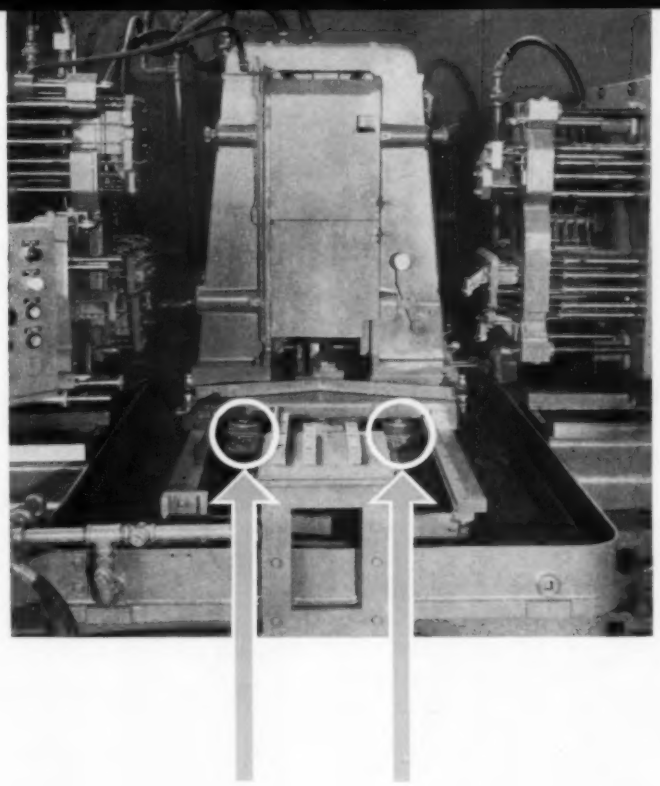


Fig. 1—Remotely located pressure switches are used to give reliable indications of positions of shot bolts in this National Automatic Tool Co. special purpose multispindle drilling unit. Limited-space locations of shot bolt actuators indicated by circles precluded use of limit switches in this application.

APPLYING PRESSURE SWITCHES

FOR POSITION CONTROL

Pressure switches perform many useful functions involving the sensing and control of pressure conditions in hydraulic circuits. It is suggested that their use can safely be extended to check terminal positions of actuators in properly designed circuits.

By **E. E. OPEL**, Electrical Engineer, National Automatic Tool Co., Inc., Richmond, Ind.

PRESSURE SWITCHES are useful devices in many hydraulic circuits because of their ability to open or close electrical contacts in response to preset pressure levels. In signaling and control applications the operation of their contacts can indicate that a desired pressure has been reached, has been exceeded, or has not been attained.

In clamping and holding operations, for example, pressure switches can indicate that proper holding forces are being exerted and prevent subsequent machine actions if they are not. Indicating or preventing excessive pressures can also be accomplished through their use. Other applications employ pressure switches to indicate and/or correct below-normal pressures as in accumulators and automatic air mist and forced lubrication systems.

The foregoing types of applications employ the switches directly, i.e., to give electrical signals indicative of pressure conditions. Indirect applications are sometimes contemplated also. An example would be use of pressure switches in supply lines to indicate complete stroking of cylinders, since pressure rises at the ends of piston strokes in many hydraulic circuits.

A distinction arises in indirect applications, however, in that the switches are then being used as inferential devices, and can give false signals even when they are operating properly. In the case of sensing the completion of a cylinder stroke in terms of pres-

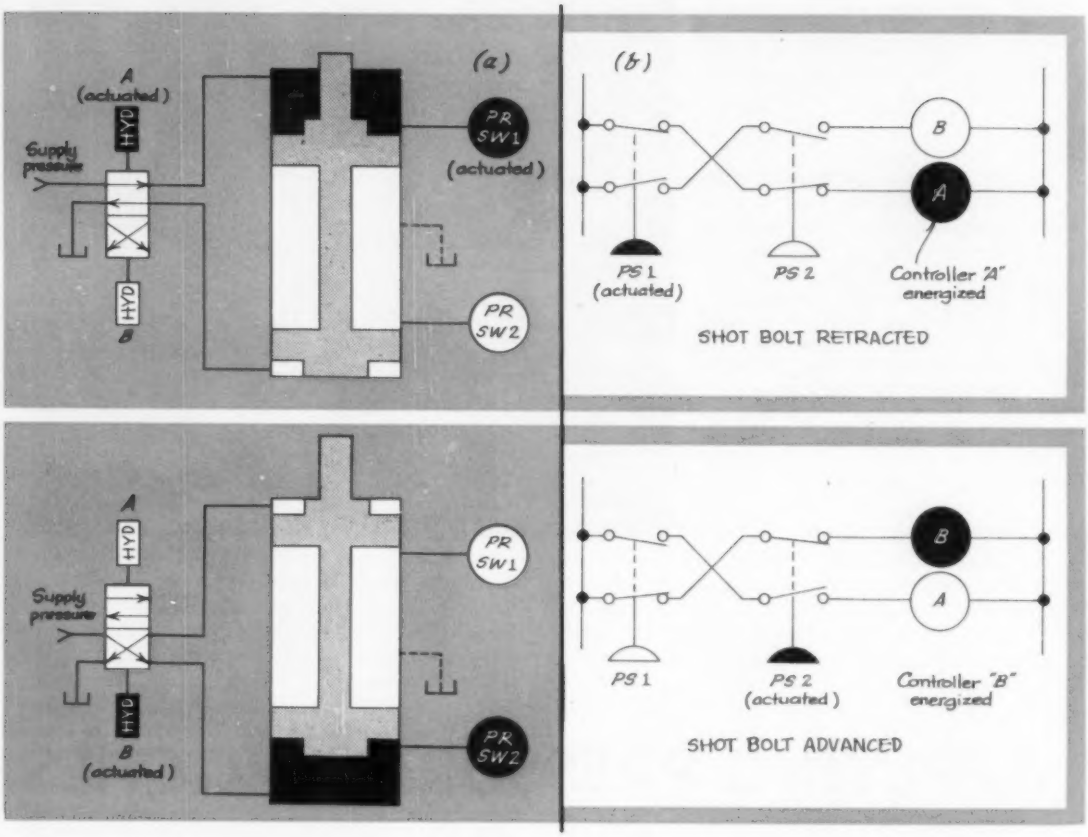


Fig. 2—Hydraulic diagram shows shot-bolt actuator in its fully retracted and advanced positions (*a*). Unique porting arrangement of actuator requires that shot-bolt piston be in one of these terminal positions before pressure switch circuit is completed. Electrical diagram (*b*) shows contact positions for corresponding positions of shot-bolt pistons.

sure rise, for example, the pressure switch would interpret pressure increases from all causes to signify completion of the stroke. A machine jam or other unexpected load on the piston at any stroke position could thus actuate the pressure switch and cause an erroneous indication that the stroke had been completed.

This possibility has perhaps contributed to the recommendation in JIC Electrical Standards E-14.4.2-T that "Pressure switches shall not be used alone to determine sequence of operation."

Other reasons are based on shop experience. There is no doubt that pressure switches can give incorrect signals if they are not used carefully. Interlocking based on fixed-pressure operated switches can be very dangerous. This is true whether the switches are used to control electrical sequences or hydraulic sequences where pressure causes hydraulic valves to move and start new functions.

Most of the field trouble experienced with pressure switches has been due to pressure peaks and valleys caused by the operation of valves. These pressure changes are often so fast they do not show up on pressure gages that have surge protectors. They need exist only momentarily, however, to cause pressure switches to flutter and possibly cause serious damage to equipment that depends on accurate switch operation. If the pressure surges are sufficiently high, they can also damage diaphragm type pressure switches. Piston type switches are less susceptible to damage by pressure peaks.

Back pressure in the drain line is often high enough to affect the operation of pressure switches, and can destroy seals and gaskets. An easy check for malfunctioning due to excessive back pressure is to disconnect the drain line at the pressure switch—if switch operation is thereby corrected, back pressure is the cause of spurious switch operation.

Remedies for high back pressure in drain lines include use of vents and large diameter drain lines. The vents insure that the drain lines will not become full of oil. Back pressures otherwise would increase at startup and during pressure rises in order to accelerate the mass of standing oil in the drain line.

▶ Pressure vs Limit Switch Control

Pressure switches should be used in applications for which they are designed, i.e., indicating pressure

levels. Limit switches mounted at points of interest are the usual choice for sensing position, but they cannot check whether the desired pressure is being applied. Position *and* pressure detection therefore usually requires both devices—a limit switch to show that the member has moved to the correct position, and a pressure switch to indicate that the proper pressure is being applied. Exceptions to this rule will be described later.

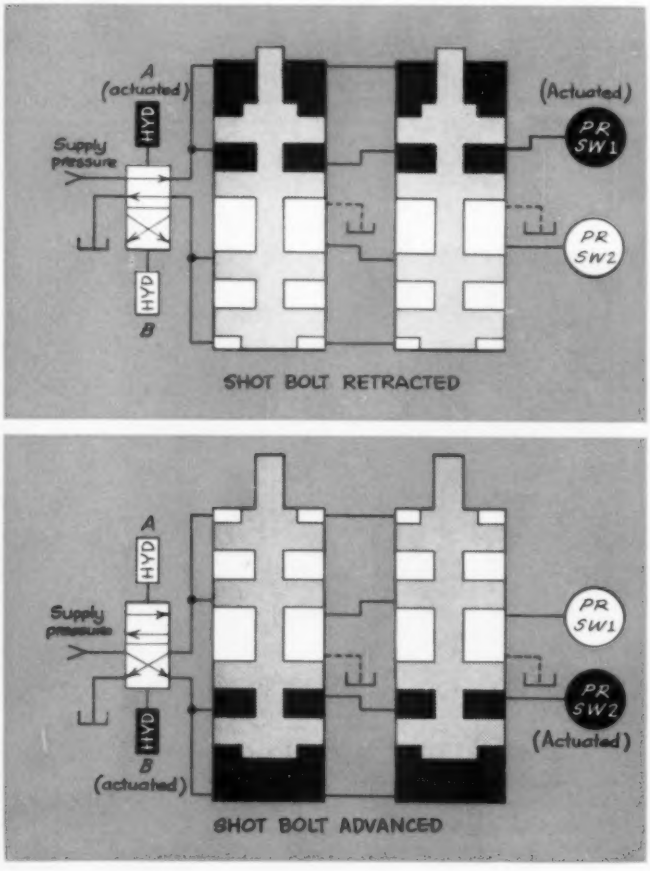
Circuits that can profitably employ both pressure and limit switch control include those for parts clamping and for exerting predetermined pressing forces as in assembling bushings in holes. In such applications the danger of false signals due to pressure peaks and valleys can be reduced by hydraulic and electrical means. Hydraulic surge protectors such as those used on gages can smooth out the pressure peaks acting on switches, while time delay relays can be incorporated in the electrical circuits to give the system time to stabilize before the signal from the pressure switch is read out.

Special Circuits

Occasionally it is necessary to sense accurately the positions of actuators when it is difficult or impossible to mount limit switches in the vicinity of the controlled elements. An example is in the shot bolt arrangement for a National Automatic Tool Co. special purpose multispindle drilling unit, *Fig.* 1. In this case it was decided to use a modified-design hydraulically operated shot-bolt actuator, *Fig.* 2, so that pressure switches alone could reliably indicate that the shot bolts are extended or retracted.

The shot-bolt cylinder, *Fig.* 2(*a*), is ported so that pressure switches *PR SW* 1 and *PR SW* 2 are connected alternately to pressure and tank when the shot-bolt piston is in its fully retracted and advanced positions. If small ports are provided a very accurate check of the actual piston positions can be obtained. By suitable electrical wiring of the pressure switches, *Fig.* 2(*b*), both switches must be correctly operated to provide signals indicative of shot bolt positions. These signals may be utilized to actuate indicators, disable alarms, or control subsequent machine actions. The switches may be mounted remotely and connected to the actuator through small diameter hydraulic lines.

The arrangement of *Fig.* 3 employs two hydraulically operated shot-bolt actuators which are interlocked by pressure switches. In this circuit both shot-bolt pistons must be fully retracted in order for pressure to actuate *PR SW* 1. At this time *PR SW* 2 is drained to tank. When both shot-bolt pistons are fully advanced *PR SW* 2 is actuated by pressure and *PR SW* 1 is drained to tank. Port locations and piston configurations insure availability of pressure to move the shot-bolt pistons, and prevent operation of the pressure switches until the shot bolts are in their final locations. Electrical connections for the switches are the same as in *Fig.* 2.



Dual Function

In shot bolt applications the hydraulic pressure is not critical; as long as it is sufficient to operate the switches it will indicate position. In cases where it is desired to insure that a certain pressure is being applied the pressure switches can be set to indicate this also. In clamping circuits, for example, uncovering of the cylinder ports by movement of the piston can check locations, and the settings of the pressure switches can check clamping forces. Readout does not occur until the clamps have operated. If pressure is to be maintained care must be exercised that the switches do not flutter on pressure valleys and drop out electrical holding circuits.

Misapplications, rather than inherent defects, account for much of the unpopularity of pressure switches for position detection. In properly designed systems such as those of *Fig.* 2 and 3, dependable indication of the terminal positions of actuators is readily obtainable through their use.

Fig. 3—Two shot-bolt actuators are connected to operate together in this circuit. Shot-bolt pistons must complete strokes in the same direction before useful signals are available from the pressure switches.

DEVICES HANDLE HEAVY STAMPINGS AUTOMATICALLY

HEAVY STAMPINGS, automatically stacked in pallets as they emerge from a blanking press, are subsequently fed automatically to a transfer press from the same pallets in an automotive plant installation designed and built by Michigan Production Engineering Co.

In the stacking operation, *Fig.* 1, C-shape stampings weighing approximately 15 pounds each are delivered to the upper, or preloading, section of an automatic stacker by an inclined belt conveyor leading from the blanking press. Parts are collected and aligned by the preloading section until the stack reaches a predetermined height. When this occurs, hydraulically-operated dogs in the preloader automatically retract, and the stack of parts drops into a pallet underneath.

When the pallet under the preloading section has received a stack of parts, locking dogs release, and the pallet is ejected to a gravity roller conveyor leading to an unloading station. At the same time an empty pallet, delivered by fork truck to a loading station, is transferred to a position under the preloading section and locked in place.

During the pallet transfer period, the hydraulically operated dogs in the preloading section are prevented from retracting by electrical means. At a press rate of 30 pieces per minute, up to 60 pieces can be accumulated in the preloading section during this operation.

Pallets containing stacks of parts are removed from the unloading station of the stacker by fork truck. They may be delivered to storage as float stock, or directly to an automatic loader for a transfer press, *Fig.* 2.

A full pallet placed in the loading station of the automatic loader actuates a hydraulically-operated shuttle that carries it to a center station where it is locked in place. There, a hydraulic ram under the floor rises through an opening in the bottom of the pallet and lifts the stack of parts to a magazine area. Dogs in the magazine area extend to hold the stack of parts in a raised position, and the hydraulic ram retracts.

To overcome the tendency of the blanked parts in the magazine to stick together due to oil film, they are separated by magnetic fanners. Thus, they are easily picked up one at a time by vacuum cups and deposited on transfer arms for transport to the die area.

When the hydraulic ram retracts to its lowest position, the empty pallet in the center station is released and ejected onto a gravity roller conveyor that leads to a discharge station. Pallets are removed from this station by fork truck and are delivered to storage or back to the automatic stacker for the blanking press.

At the same time that an empty pallet is ejected onto the gravity roller conveyor, a full pallet is shuttled into position in the center station and locked. When the supply of parts in the magazine is reduced to a predetermined level, the hydraulic ram lifts its stack of parts into the magazine and the cycle continues.

This installation serves as an excellent example of the handling of parts by automated means. Its principles might well be extended to applications remote from the automotive field.

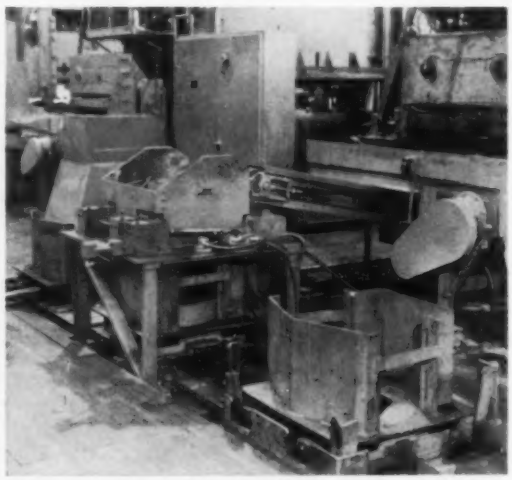


Fig. 1—Automatic stacker receives heavy blanked parts from press, accumulates them in aligned fashion in a preloader section, and drops completed stacks into waiting pallets. Shuttling of full and empty pallets out of and into preloader area is automatic.

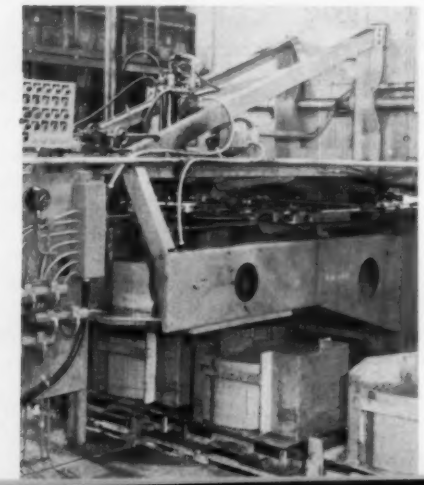


Fig. 2—Automatic loader for transfer press receives pallets containing stacked blanks and shuttles them to a center station where a hydraulic ram lifts stacks to a magazine for pickup one-at-a-time by vacuum cups. Movement of pallets in loader is automatic.

Fig. 1—Obsolescence may occur because equipment wears out, is no longer required, is incapable of accomplishing changed job requirements, or is uneconomical when compared to newer equipment.

BUY OR RENT?

NOW OR LATER?

OBSOLESCENCE AND EDP

Successfully anticipating the future is the mark of good management. Those managers investigating or faced with a decision on electronic data processing systems will appreciate this realistic appraisal of the future of components for data handling equipment.

By **ROGER L. SISSON**, Canning, Sisson and Associates, Los Angeles, Calif.

ONE of the common reasons for postponing the acquisition of an electronic data processing (EDP) system, or of renting instead of buying, is a feeling that equipment for such systems becomes obsolete rapidly. What are the facts? Does a realistic analysis support—or refute—the belief that present EDP equipment is especially prone to obsolescence?

To answer these questions, we must first review certain facts about "obsolescence," *Fig.* 1. Data processing equipment can become obsolete for any of four reasons: 1. It wears out. 2. It is no longer required. 3. The user company desires to do a much bigger data processing job on the equipment than before. 4. New machines are so much more efficient that it becomes economical to replace the old one. As to the first reason, EDP systems do wear out, but their life, with good maintenance, is at least 15 years. This would justify neither a decision to postpone acquisition nor a decision to rent instead of buy, assuming that buying is otherwise justified. Considering the second reason, modern EDP systems are based on internally programmed general-purpose computers which can be reprogrammed to process new and changed applications. They are not likely to become obsolete simply because the need for them no longer exists.

The third reason appears to be the most common and the only legitimate reason for saying that an EDP system is obsolete after only two, three, or five years. If a company has made only a short-range estimate of its data processing requirements (for example, by including just accounting functions), it *should* expect its system to become obsolete when management realizes the

benefits to be obtained from an integrated data processing system which can be applied to *all* important functions within a company.

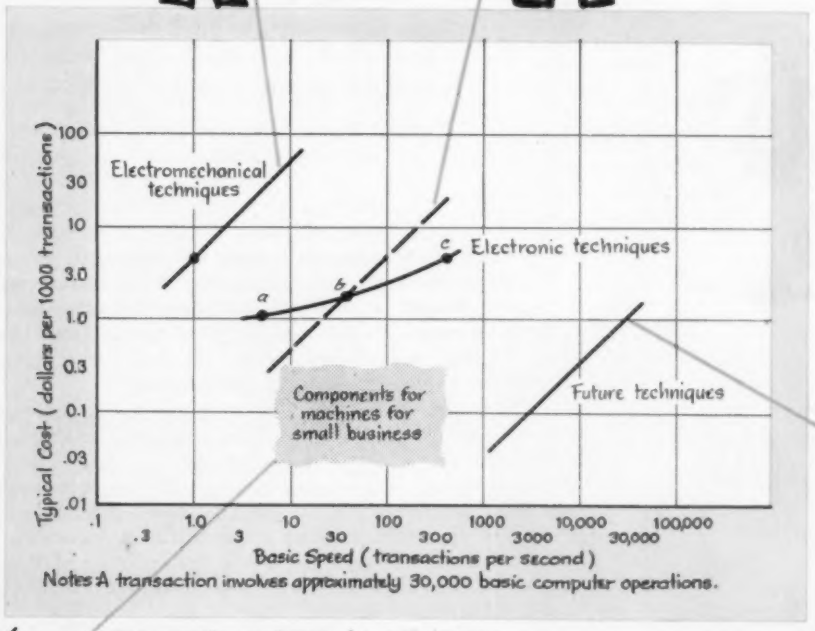
Assume, however, that a company has made the best estimate possible of future data processing requirements and has chosen a machine that will handle the load for, say, 10 years. Should it be concerned about the fourth reason—technological obsolescence during that period? The answer appears to be "no." *Fig.* 2 illustrates certain aspects of the present technological situation. The two vital equipment factors are the speed and the cost of processing a typical business transaction. To make the figures a convenient size, cost per 1000 transactions is plotted.

Three techniques are shown: Electromechanical, which is typified by punched-card machines; electronic; and some future system which is presently unavailable. For each technique, a line is drawn which represents the capabilities of systems of various sizes and complexities utilizing the given technique. Within a given technique one can move only up and to the right on the graph. That is, by spending more money one can obtain more speed with any given method of processing data. *It is only a breakthrough to a new information processing component which permits a movement down and to the right simultaneously; that is, which permits faster speed at the same or lower cost.* Use of the vacuum tube instead of relays is such a breakthrough.

The question of technological obsolescence becomes a problem of assessing the probability of a breakthrough in data processing equipment components (ready for use in reliable, commercially available equipment). The answer appears to be

Electromechanical techniques are typified by use of punched-card machines and such components as relays. Elements used in this class of techniques have moving parts which, because of inertia, friction, and such factors as allowances for handling of discrete cards, are definitely limited in speed of operations.

Electronic techniques involve wide use of such components as tubes, transistors, and magnetic memory devices. Experience suggests that cost is related to speed of operations as shown by the solid line and not in direct proportion as shown by dotted line. Points **a**, **b**, and **c** indicate, respectively, medium-size, large-size, and extra-large electronic systems.



Data processing requirements for small businesses could be expected to be satisfied if developments resulted in techniques that fall into this shaded area of cost versus speed. Disclosed developmental work gives no hope that such techniques are forthcoming. The important consideration of cost will best be fulfilled by some future technique which will probably possess speed characteristics that exceed small business requirements.

Future techniques, presently in various stages of development, are typified by the use of such items as superconducting components. Important technological progress takes place when a development results in both lower costs and increased speeds.

Fig. 2—Inherent capabilities of components predominantly used in various data processing equipment permit their classification into general groupings or techniques. For the three indicated techniques, relationship of speed of transactions and cost of performing transactions is shown.

TABLE 1—Components for internal memory and computational circuits

	Technique	Developed By	Speed (Operations or accesses per sec.)	Cost (per Digit of Memory Capacity or per Logical Component)	Comparison Factor (Speed per Cost)	Binary Digits per Cubic Inch	When Available in Commercial, Proved Equipment	Reference
1a.	Vacuum Tubes	Various	10 million	$3-10	30,000	1-5	Now	
1b.	"		100 million	$10-100	100,000	1	3-5 yrs.	Standard Electronics Literature
2.	Transistor	"	100 million	$3-10	300,000	1-100	0-3 yrs.**	**Proc. Western JCC, Feb. 1957, p. 68-72
3.	Magnetic Core	"	1 million	50c	20,000	100	Now	
4.	Magnetic Plate	RCA	1 million	10c*	100,000	400	2-5 yrs.	IRE Proceedings Vol. 45, #3 March 1957, p. 325-334
5.	Magnetic Wire	Bell Labs.	1 million	10c*	100,000	100-500	3-5 yrs.	Bell Labs. Record, Dec. 57, p. 488-9
6.	Super-conducting	IBM, M.I.T.	100 million	10c*	10 million	100,000 to 10 million	7-10 yrs.	IBM Jour. of Res. & Dev. I, #4, Oct. 57, p. 294-308
7.	Chemical	NCR	1 million*	1c*	1 million	1 million	7-10 yrs.	Business Week, Dec. 7, 1957 p. 120-122 Wall St. Jour. Nov. 13, 1957 p. 2
8.	Ferro-electric	Bell Labs. & others	100 thousand	0.01c*	100 thousand	100,000 to 10 million	4-7 yrs.	IRE Proc., Vol. 45 #8, Aug. 57, pp. 1094-99
9.	Nuclear Resonance or "Spin-echo"	Various Research	Basic physical phenomena still under investigation				7-15 yrs.	

*Author's estimate

that the probability of a breakthrough before 1966 is extremely small.

Two additional comments should be made about *Fig.* 2. Firstly, as suggested by the line for electronic techniques, present large EDP systems seem to be more efficient than small ones, so that costs may not increase directly in proportion to speed. Point *a* might be equivalent to medium-speed (drum) machines, point *b* equivalent to large-scale (core) machines, and point *c* to the extra-large machines of the STRETCH and LARC class.

Secondly, what about the prospects for filling the void of machines for small business? Will there be components which are not necessarily fast but are very inexpensive, as in the shaded area of *Fig.* 2? Present prospects for filling this void appear dim, unless some completely undisclosed projects are under way. If the future techniques suggested by the graph are developed, they may be cheap enough, even though fast, to be useful to the small business' problems—but realization of that hope is a number of years off.

▶ Analysis of Components

Supplementing the conclusion that true technological obsolescence is created only by a breakthrough in the design of new information processing components which operate at higher speeds for less cost, TABLE 1 reviews the components now under development and estimates the time by which they will be available in reliable, commercial equipment.

Several comments are in order. External memory devices such as magnetic tapes are not discussed. When internal memory components and logical elements are cheap enough not only the working data but also most of the active files will be stored in extremely large internal memories. External memories, if needed at all, can then be relatively slow, cheap units which do not limit processing speed as is now the case. For example, with good systems engineering and operations research work, a typical business might require a total of 100 million characters of data in its active files. At one cent per binary digit, the memory would cost $7 million (there are 7 binary digits per character). This cost might well be justified in the future when the full value of a good information system is appreciated; present costs for much more limited systems are almost as great and it is to be remembered that such gigantic internal memories will give true random access.

In addition to the some 700 million memory components, about 10,000 to 100,000 components will be required for the arithmetic, logic and control system; the larger figure will be needed by the faster and more complex systems.

▶ Superconducting Components

From a comparison of the data in the table, it can be concluded that only the superconducting elements may possibly offer a significant improvement in speed-per-cost factor. (It should be emphasized that the cost figures for the components still in the research stage are the author's estimates

OBSOLESCENCE AND EDP

and the speeds shown in TABLE 1 are those technically feasible, not necessarily being realized now.) The superconducting elements are based on the peculiar phenomenon that certain metals have no electrical resistance when cooled to near absolute zero (−459 F). Liquid helium, which can be used to cool to such temperatures, is now relatively cheap and abundant so that techniques requiring such low temperatures are now possible. Latest research indicates that the actual components can be made by spraying metallic films on nonconducting bases, which promises cheap production costs for large volume memories.

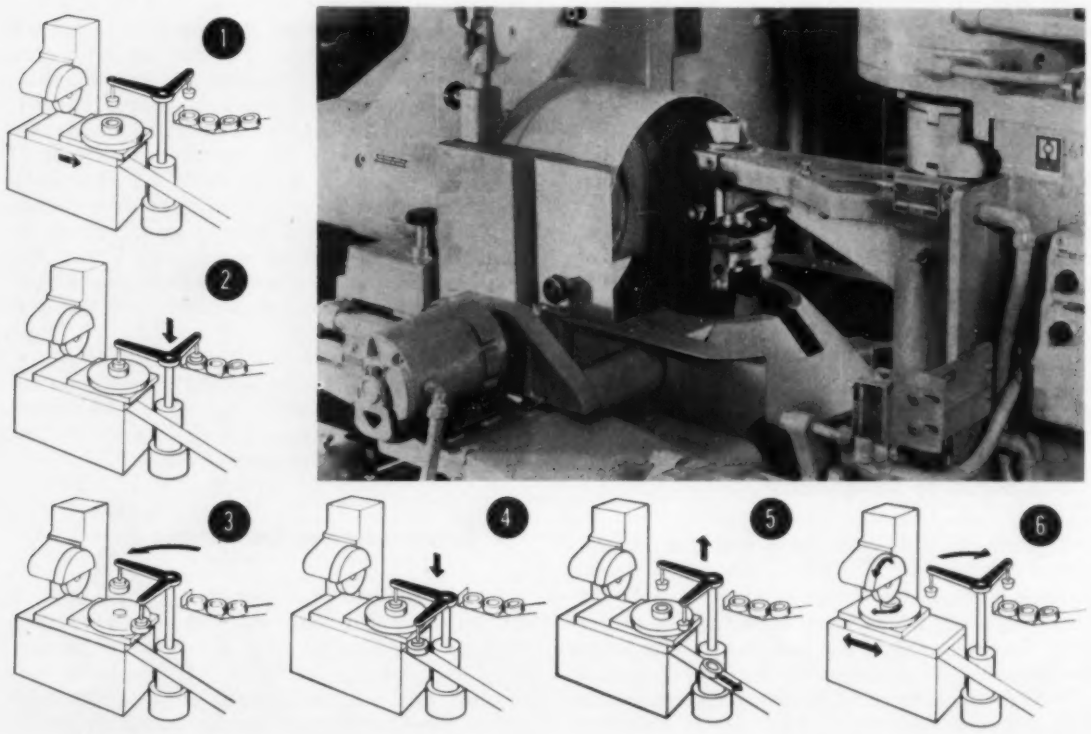
Judging from the experience with the transistor, however, it will be at least 8 to 10 years before these superconducting elements, or some equivalently effective components, result in speed increases and cost reductions in computers available to commercial users. This leads to the conclusion that, if a computer has been selected to fulfill the needs of the company for the desired planning period, technological obsolescence cannot be expected for 8 to 10 years.

surface grinder loaded-unloaded automatically

HYDRAULICALLY-OPERATED mechanism has been developed by Heald Machine Co. to load and unload parts from its line of standard rotary surface grinders.

Key to the mechanized system is a hydraulically-operated, L-shaped arm that loads unground parts into the chuck of the grinder at the same time it unloads finished parts. Referring to the small sequence diagrams, operation of the mechanism is as follows: 1. Grinding table moves finished part horizontally to unloading station. 2. L-shaped arm lowers engaging finished part on one arm and unfinished part on other arm. 3. Arm raises, lifting parts, and indexes 90 degrees counterclockwise. 4. Arm lowers, depositing finished part onto unloading chute and positioning unfinished part into air-operated chuck of grinding machine table. 5. Arm raises, leaving parts in chute and chuck. 6. Grinding table moves unfinished part under grinding wheel and arm indexes 90 degrees clockwise to starting position.

Postprocess gaging station on the unloading chute checks the finished size of each part automatically and actuates warning lights to indicate out of tolerance parts. The gage also feeds signals back to the diamond wheel dresser unit, automatically correcting any tendency of the part to drift out of size.



ASSEMBLY BY DIECASTING

IMPROVES PRODUCT QUALITY

By PAUL L. DESCHENES
Supervisor, Advanced Manufacturing Engineering
General Electric Co.
Somersworth, N. H.

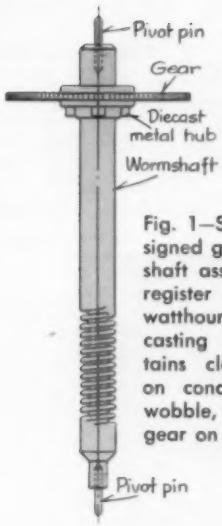


Fig. 1—Sketch of redesigned gear and wormshaft assembly used in register mechanism of watthour meters. Diecasting of hub maintains close tolerances on concentricity, gear wobble, and location of gear on shaft.

QUESTS for cost-saving manufacturing methods lead naturally to consideration of automation. Often, in the accomplishment of more automatic operation, benefits in addition to those originally needed to justify the equipment are obtained. For example, the planning necessary for effective automation of operations may reveal opportunities to simplify the product or adopt more efficient production processes in its manufacture. Also, improvements in product quality, which were not originally contemplated, are a frequent result of automation.

Such has been the experience in the upgrading of manufacturing methods for watthour meter components at the Somersworth, N. H., plant of General Electric Co. There, operations in the manufacture of gear and wormshaft assemblies and guide bearings have recently been reviewed and improved.

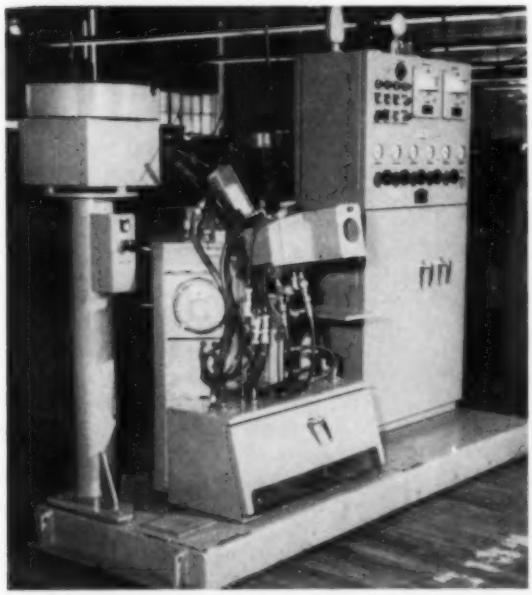


Fig. 2—Diecasting machine automatically assembles gear and wormshaft assemblies shown in *Fig.* 1. Gears are fed by hopper and wormshafts are supplied by a magazine. Probing devices check progress of parts through the machine.

Gear and Wormshaft Assembly

The gear and wormshaft assembly, *Fig.* 1, is used in the register mechanism of watthour meters. Performance requirements demand close tolerances with respect to gear O.D. and wormshaft pivot pin concentricity, gear wobble, and location of the gear from the end of one of the pivot pins.

After an evaluation of the original and several alternate production methods it was decided to modify the old design of part which required that a brass hub be staked to the gear, subsequently bored, and the assembly staked to the wormshaft. In the new design, the hub is diecast in place by an automatic machine, *Fig.* 2, which was obtained from Fisher Gauge Works Ltd., Peterboro, Ont. Output of this machine is 1000 assemblies per hour.

The machine accepts wormshafts that have pressed-in pivot pins and feeds them automatically from a magazine into one-half of the diecasting mold. Gears placed in the bowl of a vibratory feeder are supplied to the other half of the mold.

When the feed mechanisms for the magazine and the vibratory feeder have been actuated, the mold closes. Probes in the mold then sense the presence of the parts and check that they are positioned properly in the mold. If, for example, a pivot pin is missing or is loose in the wormshaft so that probe pressure can displace it, the cycle stops and will not continue until the defective part is removed manually and replaced.

Assuming that the parts are present and not defective, the mold is swung to a position above an injection nozzle. If the mold is not properly seated on the nozzle, the cycle will halt. When the mold is properly seated an air-operated plunger injects metal into the mold cavity and retracts. One of

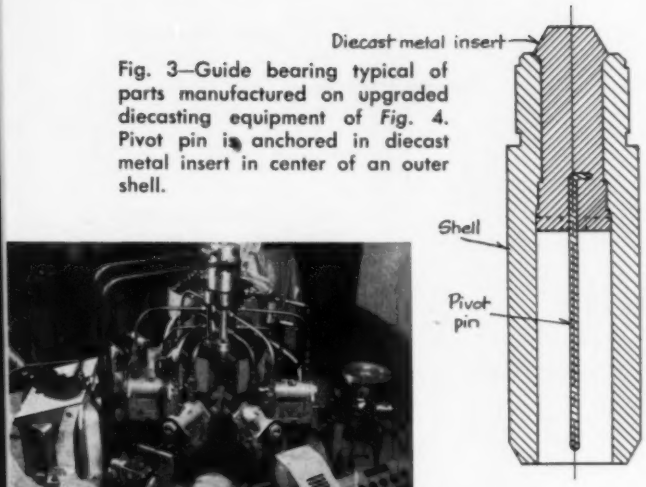


Fig. 3—Guide bearing typical of parts manufactured on upgraded diecasting equipment of *Fig.* 4. Pivot pin is anchored in diecast metal insert in center of an outer shell.

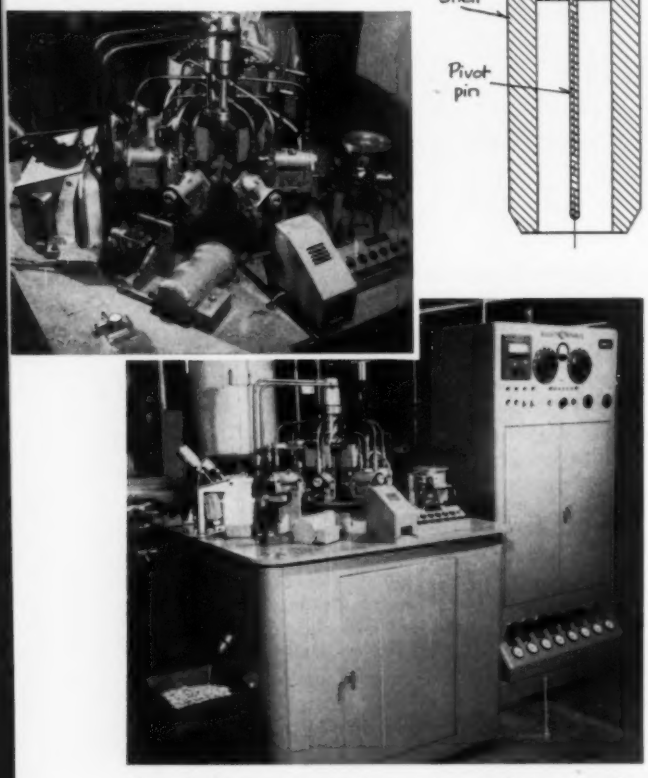


Fig. 4—Automatic six-stage rotary indexing machine forms pivot pins and assembles them to shells by diecasting to produce guide bearings for watthour meters. Enlarged view of indexing table shows mold halves that are advanced radially outwardly by air cylinders to engage fixed mold half at diecasting station.

the mold halves then rotates slightly to shear the sprue and both halves withdraw from the nozzle. Thus, there is no second operation required to shear the sprue at the gate, and handling of sprues for remelting is eliminated.

Upon their return to the initial position the mold halves open, and a set of mechanical pickup fingers grasps the completed assembly, withdraws it, and places it on a discharge chute. Quality of diecasting is such that flash need not be trimmed from the assemblies before they are used.

The equipment is fail-safe so that, should any malfunction occur, the cycle will be stopped. When this happens, a signal lamp lights to inform the setup man that the machine requires attention.

From a product quality standpoint, concentricity problems have been eliminated and wobble is virtually cured. In the few cases of wobble still experienced, the wobble appears to be in the gears prior to assembly, and the restraining action of the mold halves is not sufficient to correct it.

▶ Guide Bearing Manufacture

Production of two other watthour meter components, namely, top and lower guide bearings, *Fig.* 3, has also been upgraded. Each guide bearing consists of a small (0.019-inch diameter) pivot pin that is diecast in place in the center of an outer shell. A bend in the pivot pin serves to anchor this member in the diecast metal.

Although the old method of assembly was by diecasting, the machine was hand loaded and operated. Because of the small size of the pivot pin, picking it up, as well as loading it in a mold opening that had only 0.0005-inch clearance, was extremely difficult. The hazard also existed of pins being pulled partly out of the mold opening when released from the grasp. This had to be avoided since an error of only 0.002 inch is permitted in the location of the end of the pin with respect to the end of the shell.

A six-station rotary indexing machine, *Fig.* 4, is now used to assemble guide bearings automatically. At the first station a hopper feeder loads straight pins into each of six male mold halves as they are indexed into position. In the next indexing position a bend is produced in the pins at their projecting ends. The next station inserts a shell over the male mold half and also probes for presence of a pin, presence of the bend, and seating of the pin against its stop. If one or more of these conditions are not satisfied, the machine is stopped automatically and a warning light flashes.

Assuming conditions are satisfactory, the table will continue to index. At the fourth station the male mold half is advanced radially outwardly by an air cylinder until it engages a fixed female mold half. At the same time an injection nozzle is advanced into the sprue hole. Again, certain requirements must be met before the next operation can take place. These are: Presence of a shell, seating of the shell, and seating of the nozzle in the sprue hole. If these conditions are met, injection of molten metal takes place and the injection nozzle is retracted. Before the next indexing motion occurs, the male mold half is retracted with an initial twisting action that shears the sprue from the part.

At the fifth station the presence of diecast metal is sensed by a probe, and the completed assembly is stripped from the mold half. If the metal is cast and in the proper place, the cycle can continue.

The sixth station is reserved for cleaning flash from the pivot pin holes in the male mold halves. This is done by running a small drill in and out of the holes, to assure that pivot pins inserted subsequently will be able to seat against the stops in the mold halves.

The new method of assembly provides greater output and improved density of diecast metal. In addition, rejects for short pins and for eccentricity of pin and shell have been reduced.

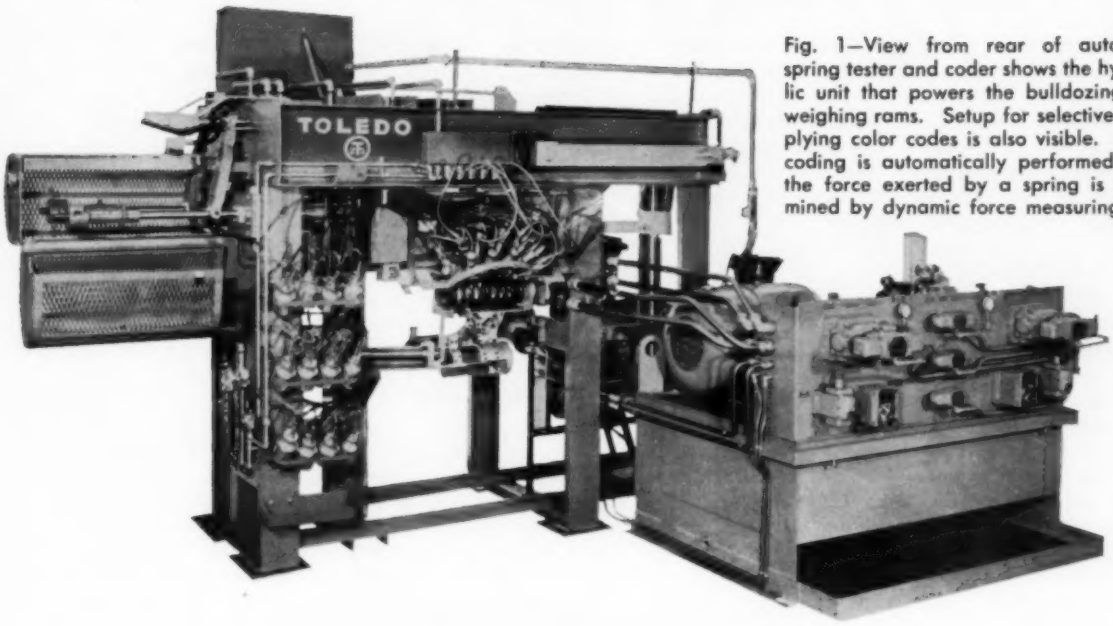


Fig. 1—View from rear of automatic spring tester and coder shows the hydraulic unit that powers the bulldozing and weighing rams. Setup for selectively applying color codes is also visible. Color coding is automatically performed after the force exerted by a spring is determined by dynamic force measuring.

DYNAMIC FORCE MEASURING

TESTS HELICAL SPRINGS

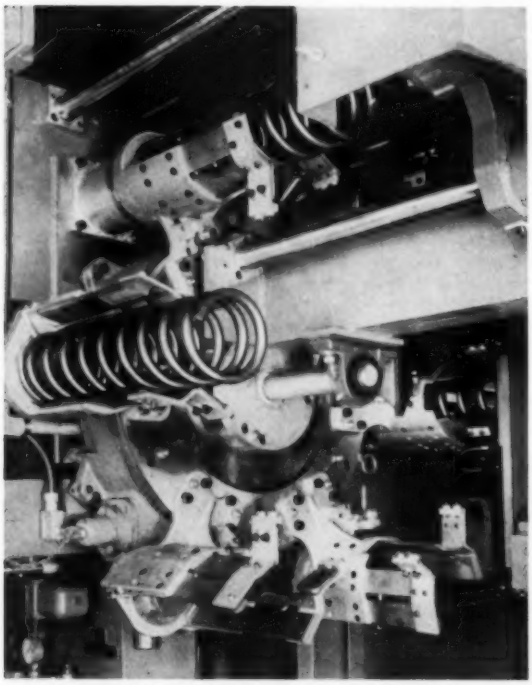


Fig. 2—Springs are manually loaded into the fixtures seen here. The fixtures are successively indexed to six stations by rotation of an index table about a horizontal axis. Initial stresses are modified in the spring at the second station where a bulldozing ram compresses and releases it.

MANY FACTORS affect the values of loads required to compress helical springs to given lengths. Due to the difficulties in trying to control all these factors in manufacture of such springs, they are usually tested and sorted after manufacture. Because of the high speed, repetitive accuracy required in testing production quantities of helical springs, the advantages of automation have been sought for such operations.

An automated machine, *Fig.* 1, has been built by Toledo Scale Co. to speedily test helical springs and selectively code them with various colors indicating the results of the tests. This machine is capable of testing 900 springs per hour at 100 per cent efficiency. It checks the forces exerted by the springs when compressed to a given length and classifies them into six categories—over, four acceptable levels, and under. Testing is performed by a dynamic force measuring method in which the scale platform does not have to come to rest to obtain a force reading. An automatic spray painting station in the machine applies different colors of paint to springs falling in the four acceptable zones and the under zone. Springs falling in the over zone are left unpainted so that they can be reworked and retested.

The machine is a six-station unit which can test springs with a free length up to 22 inches and a pitch diameter up to 6 inches. After the operator

places a spring in a fixture and turns it to position the end, *Fig.* 2, he presses two buttons in a safety interlock circuit to initiate the cycle. The fixture is one of six mounted on an index table that rotates about a horizontal axis. When a spring has been indexed up to the second station, a hydraulic "bulldozing" ram compresses the spring with a force up to 3000 pounds to modify initial stresses. The bulldozing ram is then retracted and the spring is indexed to the testing station.

Dynamic Measuring

In the testing station the spring is compressed to a predetermined length between a locked scale platform and a hydraulic ram that moves to a fixed stop, *Fig.* 3. While the ram presses against the spring and the stop, the scale platform is unlocked. The scale platform oscillates under the influence of the spring being tested and the weighing spring. The platform is allowed to complete one cycle of free oscillation before it is locked again, and the ram is retracted.

The maximum displacement of the platform under load is proportional to the force exerted by the spring under test. A measurement of this displacement can thus be converted into an expression of the force exerted by the spring at the test length. The displacement is measured in this arrangement by measuring the rotation of a glass chart which is mechanically linked to the scale platform so that rotation of the chart is proportional to platform displacement.

This glass chart has very fine lines equally spaced on its face and very close together. A narrow beam of light is projected through the glass chart and onto a photocell. When the chart is moved, the photocell senses the movement of lines across the beam of light and generates signal pulses. A counter connected to the photocell counts the pulses and thereby indicates the force exerted by the spring under test.

Color Coding

The spring is indexed from the testing station to a paint spraying station, *Fig.* 4, where it can be selectively sprayed with one of five colors of paint. The count from the force measuring station is used in a control arrangement to classify the test result into one of the six predetermined ranges or zones. The control system then actuates one of five painting heads to apply the color which is used as the code for the zone into which that spring falls.

After the color coding is performed, the spring is ejected from the machine. Simple visual inspection can then be used by an operator to sort the coded springs. The empty fixture on the machine is indexed through two idle stations before it is returned to the loading station.

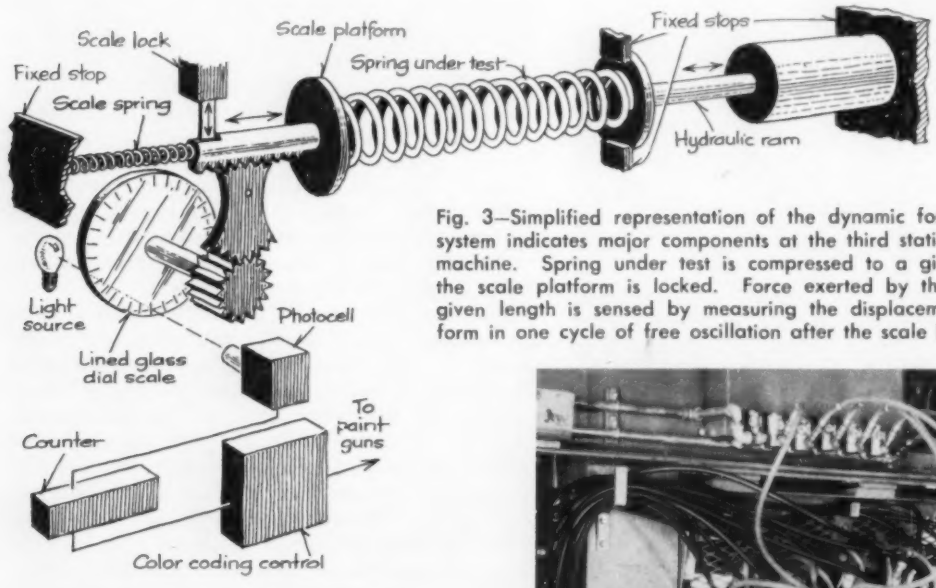


Fig. 3—Simplified representation of the dynamic force measurement system indicates major components at the third station of the testing machine. Spring under test is compressed to a given length while the scale platform is locked. Force exerted by that spring at the given length is sensed by measuring the displacement of the platform in one cycle of free oscillation after the scale is released.

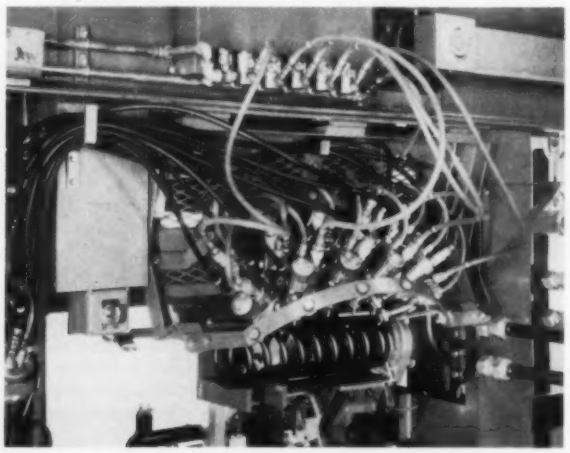


Fig. 4—Paint spray guns at the fourth station shown here are actuated by the control system to apply to the spring a color code representing the force classification into which it falls. Classification is determined by automatic comparison of the force measurement from the preceding station with a predetermined scale of ranges.

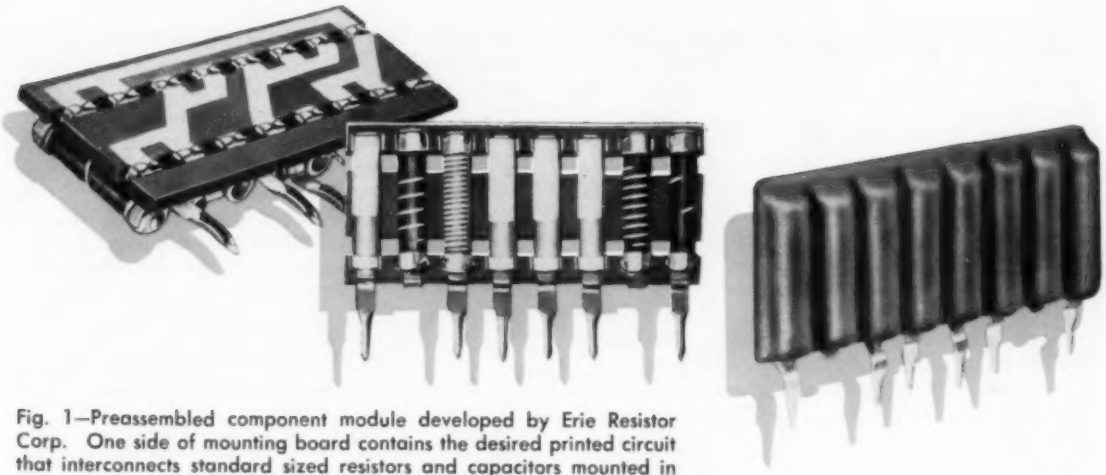


Fig. 1—Preassembled component module developed by Erie Resistor Corp. One side of mounting board contains the desired printed circuit that interconnects standard sized resistors and capacitors mounted in spring clips on opposite side of board. Assembly is then coated with a thermosetting phenolic and vacuum wax impregnated.

PREASSEMBLED COMPONENTS SIMPLIFY

MODULAR ELECTRONIC ASSEMBLY

In investigating the best way to benefit from the trend to automation, consultation with component suppliers should not be overlooked. As suppliers to many, component manufacturers are often in a superior position to design and develop improved equipment and techniques which can benefit your operations.

By **RICHARD H. ANDERSON** Application Engineer, Erie Resistor Corp., Erie, Pa.

ELECTRONIC component modules have been welcomed, although sometimes with controversy, by the electronics industry. The controversy apparently stems from a misunderstanding of basic modular concepts. According to Webster's, a module is a "standard or unit of measurement; . . . the size of some one part . . ." Thus, the word module can be any part of a system, depending on what viewpoint is taken. To the construction trades, a brick or cement block is a module since it incorporates constant size and function to produce a complete structure. And a module in electronic equipment application can be a singular unit containing circuit elements interconnected to perform a portion of the over-all circuit function.

In the electronics industry, end equipments have become more complex while the production and marketing of these items have become increasingly more competitive. As a result both the end equipment manufacturer and the electronic component manufacturer have taken steps to reduce over-all system complexity and manufacturing costs. Both goals can be attained through a common modular approach in circuit design and production, resulting in higher quality equipment at lower cost.

Consider the commercial application of electronics, such as in the manufacture of radio, TV, and phonograph sets—areas which ideally permit the adoption of the modular concept. The common denominators in all of these equipments are the passive circuit elements (resistors, capacitors, chokes, etc.) many of which may be made identical in physical size. Approximately two billion resistors and capacitors are used annually in the production of commercial equip-

ment. Another indication of the vast use of passive components is the fact that approximately 85 per cent of printed wiring board insertions are resistors and capacitors.

With the simple adoption of a modular concept, part of the twin goals of reduced complexity and lower production costs can be achieved since, by definition, an electronic component module can mean a reduction of system complexity with the end equipment being composed of one or more singular functional packages. Other advantages follow: The end equipment can be assembled in a shorter time because the modules can be previously manufactured and stocked. Component inspection is minimized, for the performance of each module may be analyzed as an entity to determine its contribution to the over-all circuit function.

However, reduction in over-all system complexity through the use of modules is only partial attainment of the desired goal since a reduction in manufacturing cost has not necessarily been achieved.

▶ Reduced Costs

The two basic areas in which an equipment manufacturer can substantially reduce his costs and consequent selling price are through a reduction in labor and material costs.

Great strides have been made in this general area. For example, today's TV set requires approximately 18 tubes for efficient operation where as many as 30 were necessary a few years ago. Consequently, the proportionate reduction of necessary passive components results in additional material and labor cost savings per set. Electronic equipments are constantly being redesigned, further reducing component parts which again substantially cuts material and labor costs.

Certainly a very lucrative area for greater economy in electronic end equipment manufacture lies in reducing production costs. Recent years have seen the advent of automatic assembly methods being applied in an effort to reduce the amount of direct labor required in the manufacture of end equipment. Expensive and complex machines have been designed to rapidly assemble electronic components to printed wiring boards. However, variations in the component mechanical parameters, such as lead spacing, physical dimensions, component volume, type of coating, and similar items, have only complicated this approach. For as component variance increases, the number of insertion equipments increases, demanding increased expenditures.

An electronic end equipment manufacturer, in initiating a mechanization program, must amortize the capital investment over the number of finished products for a specified period. In effect, this means a percentage of the selling price of the end equipment must be applied toward the mechanization program. So, as is true in most instances, a comprehensive mechanization program can be adopted only by producers with high production volumes. Smaller producers are too often denied the benefits of reduced costs through the automatic assembly of components. All of this is not meant to imply that the concept of automatic insertion of components into a printed wiring board is not sound. Preplanned mechanization of any assembly operation should aid in the desired goal of cost reduction.

▶ Role of Component Manufacturer

There is, however, a more fundamental approach to the problem of cost reduction—one that will benefit both large and small manufacturers of electronic equipment. Since the problem is one of reducing component assembly costs, the manufacturer of those very components should be consulted to see what steps might be taken at his end to aid in a module program. For example, a component manufacturer of carbon composition resistors and ceramic capacitors is already engaged in high volume production. He is supplying many end equipment manufacturers with these components that form the predominant requirement of electronic equipment. Therefore, if any program to reduce the direct labor required for finished electronic equipment manufacture is justified from the end equipment manufacturer's standpoint, it will be additionally justified from the component producer's standpoint due to the increased volume in one specific line.

This is the philosophy that underlies the development of the Pre-Assembled Component system (PAC) by Erie Electronics Div., Erie Resistor Corp. In PAC modular units, *Fig.* 1, the sound concept of standard component size has been achieved. All components are tubular shaped elements $\frac{5}{8}$ inch long x $\frac{1}{8}$ inch diameter. At present, the system incorporates fixed composition resistors, deposited carbon resistors, fixed ceramic capacitors, and Mylar

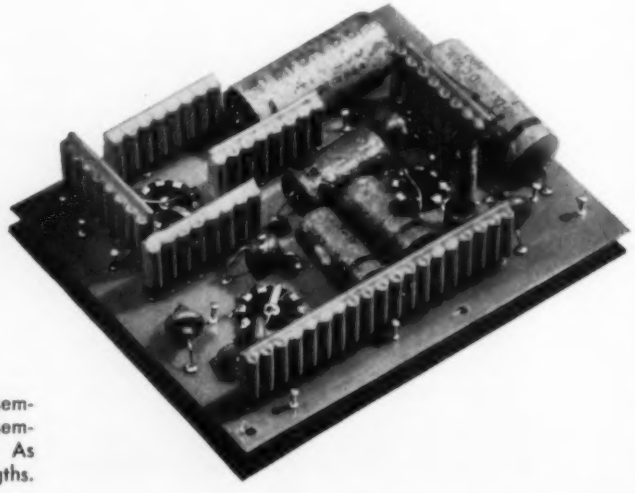


Fig. 2—Appearance of circuit board utilizing preassembled components suggests increased simplicity of assembly operation which accompanies use of such units. As shown, modules can be furnished in variety of lengths.

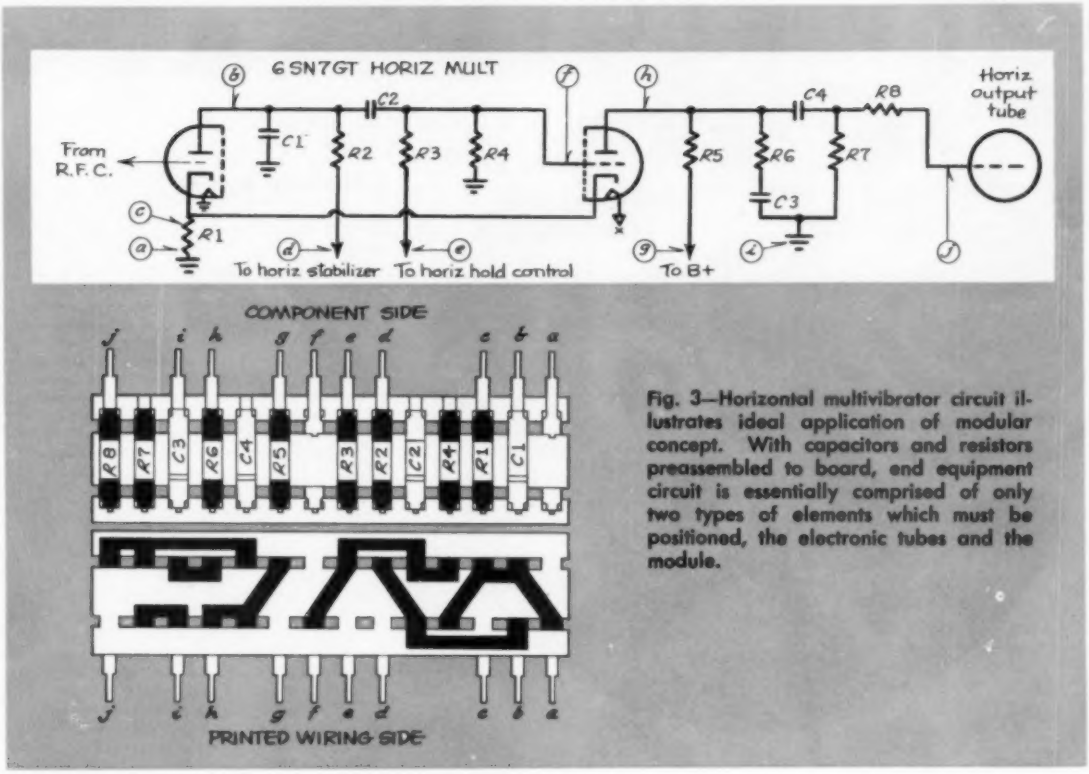


Fig. 3—Horizontal multivibrator circuit illustrates ideal application of modular concept. With capacitors and resistors preassembled to board, end equipment circuit is essentially comprised of only two types of elements which must be positioned, the electronic tubes and the module.

capacitors. Components under consideration which are suited for use in the system include tantalum capacitors, fixed inductances, transformers, and semiconductors.

Obviously, the prime benefit of this modular system is the total independence of production equipment from any variations in component physical size. This feature alone greatly simplifies the design and number of machines required for the production of modules. The single variable in the assembly of the modular system is the over-all length of the finished product as dictated by the number of components included, *Fig.* 2.

As shown in *Fig.* 3, the tubular components are positioned on a printed wiring strip which contains the particular circuit interconnections for each specific module. This is identical to presently used methods of interconnecting components through the use of printed wiring. All components are placed on 0.200 inch centers and are held in place through the use of spring clips, with the junctions being soldered.

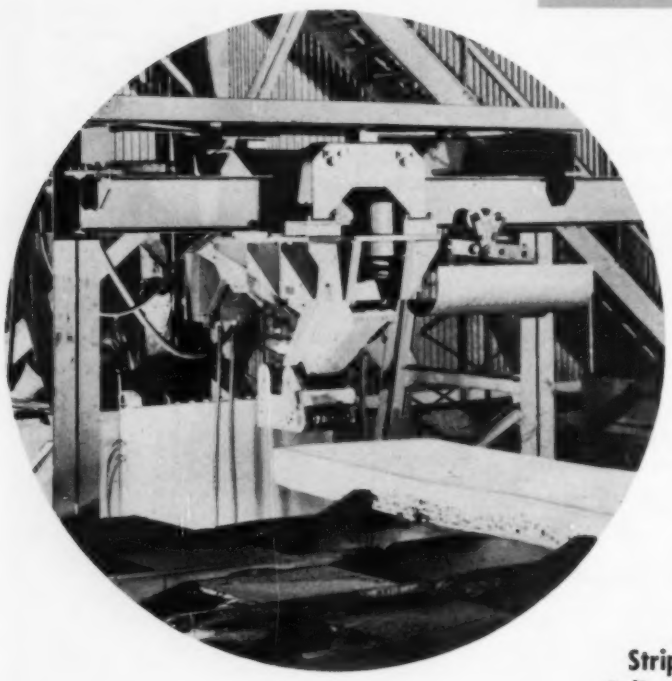
▶ Simplified Assembly

The assembly equipment needed for this product is relatively basic in design since independence from variable component size has been achieved. The importance of this one design concept cannot be overemphasized.

The concept of a separate insertion machine required for each component to be contained on the printed wiring board has been abandoned—one machine is used which can position as many as 90 components simultaneously on the printed wiring board module. Further simplification of the assembly equipment required for module fabrication is possible because each component is a mechanical and electrical entity. This basic design principle permits many electrical advantages since there are negligible coupling effects.

The module fabrication system has therefore been basically reduced to one machine peculiar to its manufacture, that being the single component-insertion machine. Obviously there are several pieces of complementary equipment required for the finishing of the module but these can be relatively simple in nature and design.

It should be noted that this module concept complements, rather than supplants, the automatic assembly of electronic components to printed wiring boards by an end equipment manufacturer. In short, the component manufacturer accepts the responsibility for supplying to the electronic equipment producer a preassembled component circuit, with terminals, which is to be assembled either manually or automatically to the main chassis board. There will undoubtedly be modifications of these principles as new and different modular systems are introduced, however, the manufacturer of mechanically semi-finished components will inevitably offer the optimum economical advantage of component assembly through modular concepts.

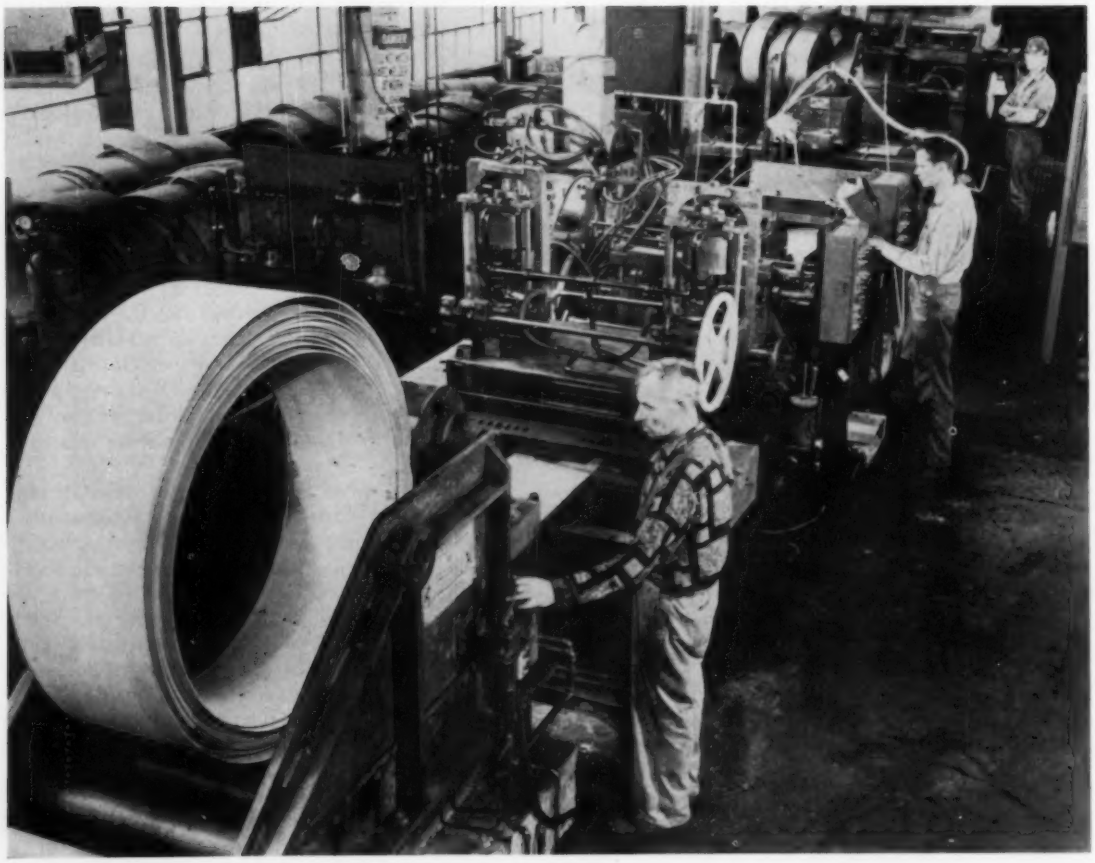


Marking System

QUALITY and production control requirements dictate that products of steel mills must be marked to show heat number and other information. Slabs and blooms at Jones & Laughlin's Aliquippa Works are stamped by a remotely controlled marker developed by M. E. Cunningham Co. The marking unit is composed of three elements: Pneumatically-powered stamping head with provisions for up to nine marking wheels; trolley-mounted mechanisms for horizontal positioning; and an operator's console which contains a series of control buttons for actuating the stamping cycle and changing characters in the marking head.

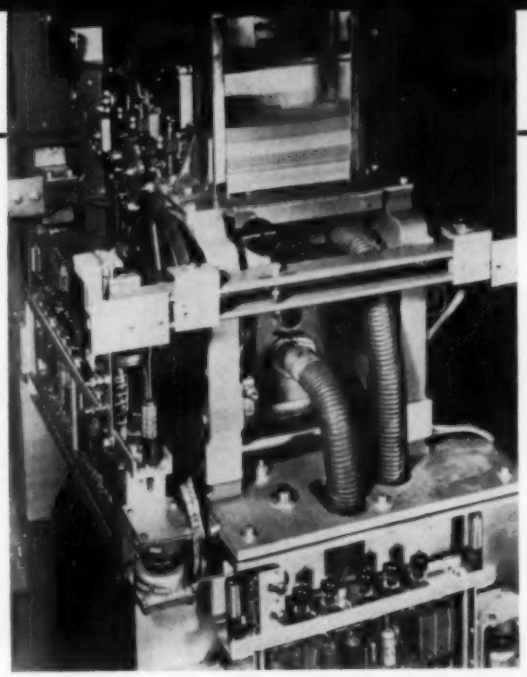
Strip Splicer

FACTORS, which limit the size of coils that can be processed, can be overcome by joining leading and trailing edges of two coils. Typical of equipment which, in effect, makes big coils out of smaller ones, permitting longer mill runs and less downtime, is this installation at the Bridgeville plant of Universal-Cyclops Steel Corp. Strip splicer furnished by Rolling Mill Div., E. W. Bliss Co. handles stainless steel coils up to 18½ inches wide, and is equipped with an annealer.

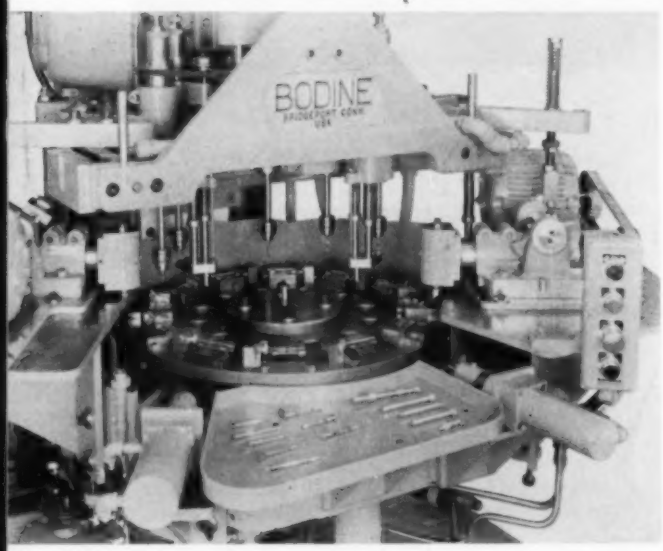


in action

Card Positioning



CARD-TO-TAPE converter in Remington Rand Univac system "reads" punched cards at rate of 240 a minute and translates the card information into electrical impulses on magnetic tape. To obtain an accurate translation, each card is read twice, and the two readings compared. When readings differ, the machine rejects the doubtful card for special attention. Because of the double reading, punched cards must be positioned very accurately where they are fed across the reader elements. In the Remington Rand equipment the cards are steadied by strong suctions provided through two lengths of flexible ducting manufactured by Flexible Tubing Corp. Electronic elements for the equipment are mechanically connected to the machine frame through vibration couplings provided by Barry Controls Inc.

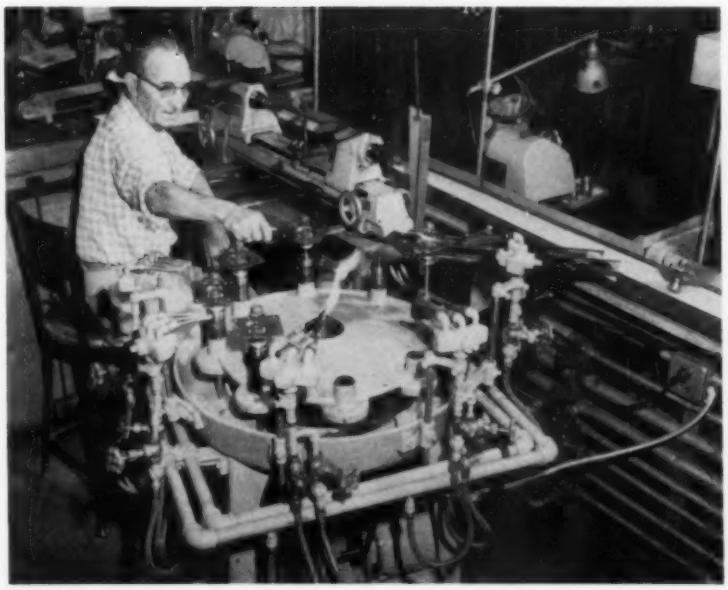


Indexing Machine

ARRANGEMENT of work-holding devices and provisions for rapid repositioning of spindles permits single machine engineered by Bodine Corp. to handle 14 variations of carburetor throttle shafts with same basic tooling. Variations in the brass shafts are based on such factors as size, location of machined surfaces, spacing of holes, etc. Parts are manually loaded onto fixtures, located by the crank end, and clamped in position. Machining operations performed include drilling, tapping, countersinking, and milling. Production is at a rate of 550 pieces per 50 minute hour with machine operating at 11 strokes per minute.

Glass Annealing

DEVELOPED by Raytheon Mfg. Co. for magnetron tube production, machine carries glass-to-metal subassemblies past gas jets in a unique annealing setup. Purpose of annealing is to equalize the stresses resulting from differing coefficients of expansion of the glass and metal joint. Subassemblies were formerly annealed in batches, which were placed in a large vacuum furnace and allowed to cool gradually—sometimes for as long as 12 hours. The new method cuts annealing time to 2 minutes for a tube. Every 14 seconds, the rotary conveyor with eight radial fixtures is indexed 45 degrees. This brings them successively in line with five groups of gas jets precisely adjusted so that an initial temperature of 400C gradually falls to 100C during a 2-minute cycle. At the end of the cycle, an inclined track raises the fixture and deposits the tube subassembly on a small roller conveyor leading to a belt conveyor for transfer to an inspection station.



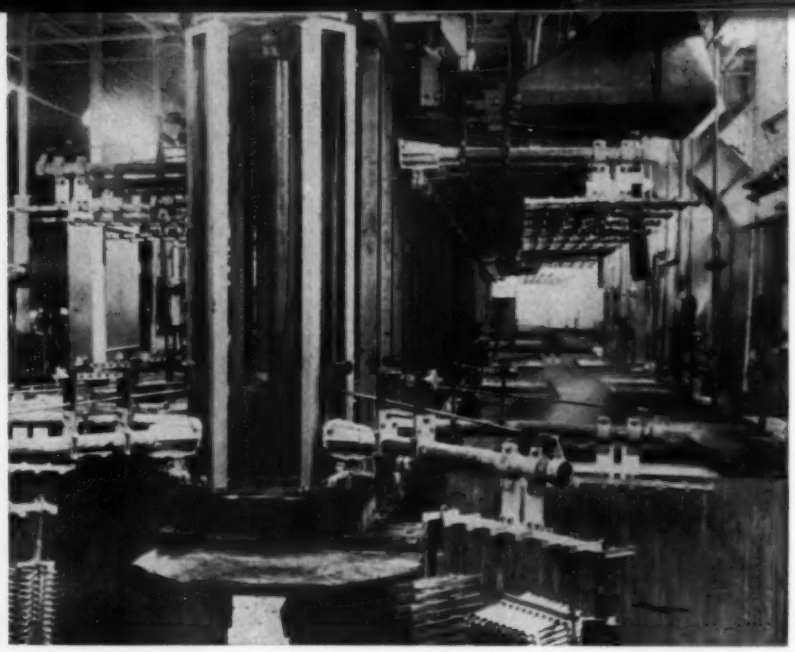


Fig. 1—Over-all view of Hanson-Van Winkle-Munning Co. anodizing machine installed in a plant of a refrigerator manufacturer. Automatic sequencing system provides four different finishes for aluminum parts on the same machine. These include two types of anodized coatings and two types of dye treatment.

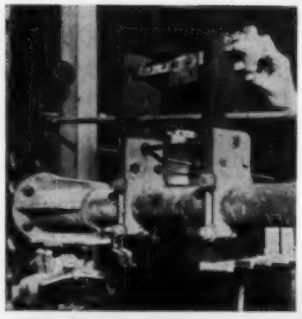


Fig. 2—Operator loads a work rack onto the carrier and dials one of the four finishing processes with the sequencing mechanism. Inset shows simple sequencing mechanism having four contact plates spaced 90 degrees apart. As the carrier is conveyed through the machine, the selected contact plate actuates limit switches which control flipper devices for bypassing the carrier over an unwanted solution.

AUTOMATIC

PROVIDES

MANAGEMENT is often faced with the problem of providing additional facilities to manufacture variations of a basic product that is produced on a single purpose machine. These variations may be due to dimensional changes which create different models of the basic product, or the addition of colors to a product line where a natural color was used previously. Sometimes, when it is economically feasible, this problem is solved by installing additional single purpose machines to handle the product variations. Other times, due to the high cost of additional machine units or limitations in available floor space, it is more advantageous to convert the existing machine to handle the variations by bypassing certain parts of the process to obtain different sequences of operation.

A large manufacturer of electrical appliances was faced with this problem of converting or adding machines when the public's fancy trended toward the use of color in refrigerators. One phase of his metalfinishing operations involved anodizing aluminum refrigerator parts on a conventional anodizing machine. Parts were conveyed on carriers through an anodizing sequence furnishing one natural finish and seal coating. When the requirements arose for varied color finishes, different thicknesses of finish, and wax or acetate seal coatings, the manufacturer required either ten separate process machines to handle the variations or con-

version of the existing single process machine so that several dye treatments and seal coats could be applied with one machine.

Since the existing anodizing machine had ample capacity to handle at least four of the new variations in process, the manufacturer referred the problem to the original supplier, Hanson-Van Winkle-Munning Co. The supplier developed an automatic sequencing system for installation on the machine, *Fig.* 1, so that by dialing a flag or contact plate located on the load carrier arm, the load would be lowered into the selected sequence processing tank or else be bypassed on a special track past the unwanted solution tank. After conversion, the single process anodizing machine provided two types of anodizing coatings, two types of dye treatment, and acetate or wax seal treatments. In addition, provisions were made to apply a lacquer coating at one station so that two-color finishes could be furnished.

Prior to anodizing, refrigerator parts are formed, welded, buffed, and washed in other areas. Parts, ranging in size from ½ x 10 inches to 14 x 26 inches, are placed on racks holding a maximum load of 75 pounds and are carried by overhead conveyor to the load-unload station of the anodizing machine, *Fig.* 2.

▶ Machine Operation

Loaded racks are removed from the conveyor and placed on the anodizing machine indexing conveyor at a rate of ten racks per minute. As each rack is loaded onto the conveyor carrier, the operator notes the treatment required and rotates the sequence selector dial, *Fig.* 2 inset, to schedule one of the four finishes provided by the machine. The machine conveyor then indexes parts through the selected anodizing sequence, dipping parts into programmed solutions and bypassing nonprogrammed tank solutions.

Carriers are raised and lowered to transfer parts between process solutions by means of an elevator

SEQUENCING MECHANISM

PROCESS SELECTIVITY

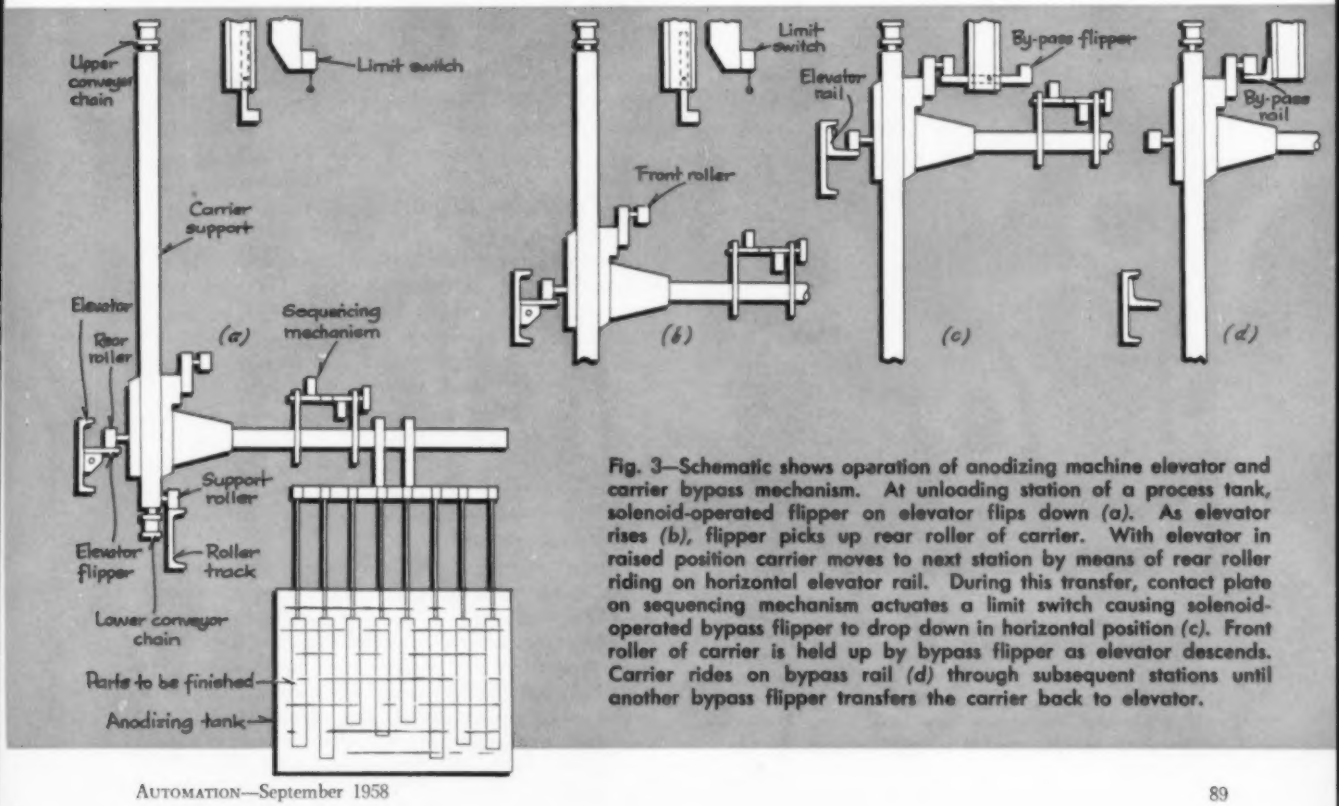


Fig. 3—Schematic shows operation of anodizing machine elevator and carrier bypass mechanism. At unloading station of a process tank, solenoid-operated flipper on elevator flips down *(a)*. As elevator rises *(b)*, flipper picks up rear roller of carrier. With elevator in raised position carrier moves to next station by means of rear roller riding on horizontal elevator rail. During this transfer, contact plate on sequencing mechanism actuates a limit switch causing solenoid-operated bypass flipper to drop down in horizontal position *(c)*. Front roller of carrier is held up by bypass flipper as elevator descends. Carrier rides on bypass rail *(d)* through subsequent stations until another bypass flipper transfers the carrier back to elevator.

beam located behind the carrier supports. At the end of a variable 4 to 100 second dwell period of parts in the solutions, the elevator starts a 27 second transfer cycle for moving carriers to the next station. Mounted on the rear of each carrier arm is a roller. A solenoid-operated flipper on the elevator beam is actuated to a horizontal position under the roller so that it will lift the carrier on the upstroke of the elevator. These flippers are stationed only at the entry and exit points of the anodizing tanks. At the top of its upstroke, the elevator stops and the conveyor indexes the carriers approximately 2 feet to the next station. During this horizontal travel the rear roller of the carrier moves on a rail attached to the elevator beam. At the next station the carrier is lowered and deposited in the next solution tank.

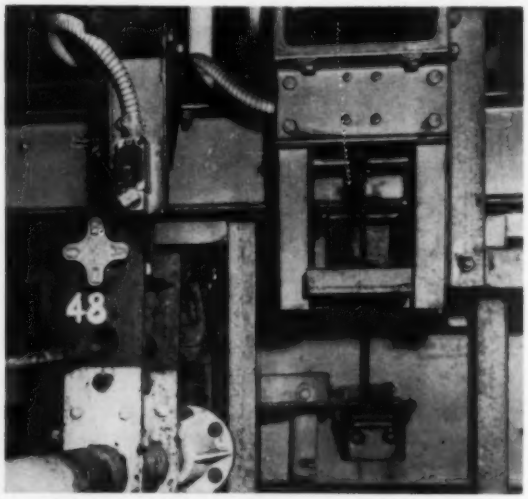


Fig. 4—Carrier at top of elevator stroke moves between stations, and sequencing mechanism attached to carrier actuates limit switch. This causes bypass flipper on right to lower into position so carrier moves onto bypass rail adjacent to bypass flipper.

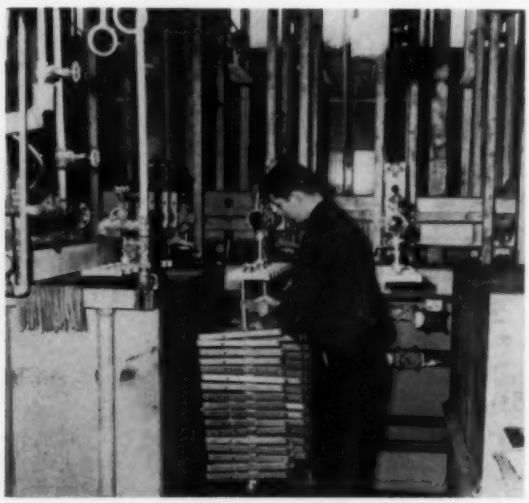


Fig. 5—Auxiliary load-unload station in anodizing machine for applying lacquer to parts requiring two-color finish. Operator unloads racks and sprays a fast drying lacquer over portion of metal that does not require color. The rack is then reloaded onto the conveyor and processed through a dye tank. The lacquer is stripped off the parts at a subsequent station.

▸ Automatic Bypass Sequence

When a carrier reaches a station in the scheduled sequence where it is required to bypass a processing tank, *Fig.* 3, it is raised by the elevator flippers and rides on the elevator rail to the next station in the normal manner. During this horizontal transfer, the contact flag on the automatic sequencing device actuates a limit switch, *Fig.* 4, which causes a solenoid-operated flipper to lower to a horizontal position in front of a bypass rail. A front roller mounted on each carrier rides onto the bypass flipper which holds the carrier in the raised position during the descent of the elevator unit. The carrier continues in the upper position through subsequent stations until it rides off the bypass rail and onto an elevator flipper for descent into a process tank.

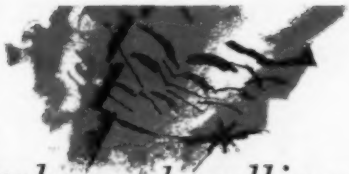
Two different immersion periods in the anodizing bath are automatically controlled by the sequencing mechanism. One process requires a 15 minute immersion period and the other process requires a 7 minute cycle. For the shorter cycle, the contact plate of the sequencing apparatus causes the carrier to bypass the initial setdown at the tank's first station, and the load advances in a raised position until it reaches the twelfth station. Solenoid-operated flippers are actuated at this point to lower the carrier into the solution for the short dwell period.

Transfer time for carriers is 27 seconds between stations. Dwell time in solution is approximately 9 seconds. Total time through the complete anodizing sequence is about 52 minutes.

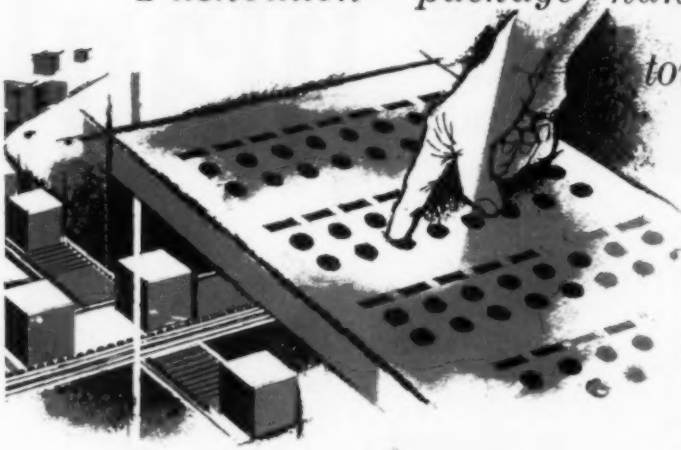
▸ Two-Color Anodizing

Certain refrigerator parts require a finish with only a portion of the part dyed. For such parts, an operator unloads racks at an auxiliary unload station, *Fig.* 5, preceding the dye tank. A fast drying lacquer is sprayed over the portion of metal that remains undyed, and the rack is reloaded on the machine conveyor. The part then moves through the dye tank and is colored on its unlacquered area. At another unload station following the dye tank, an operator strips the lacquer from the parts, and the parts continue on the conveyor through the specified sealing treatment.

Production rate on the four-process anodizing machine is approximately 100 carriers per hour based on a 9 second dwell period. The converted machine reduces labor requirements, lowers costs, improves quality, and reduces rejects and maintenance. The automatic sequencing mechanism can be applied to many other types of finishing operations utilizing automatic equipment.



"Pushbutton" package handling points toward new **PROFITS**



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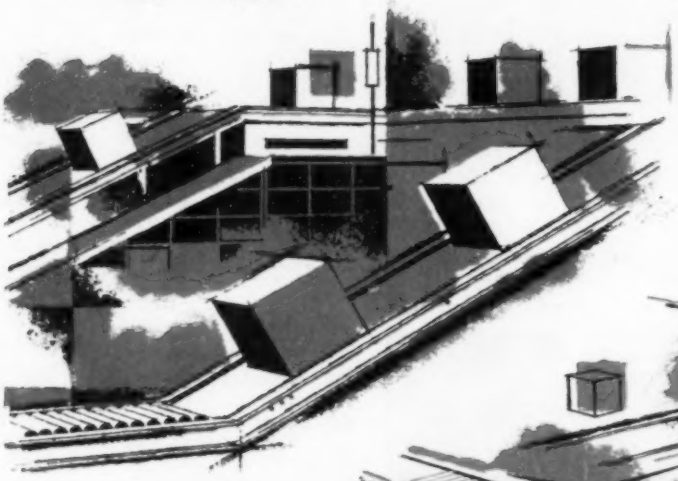

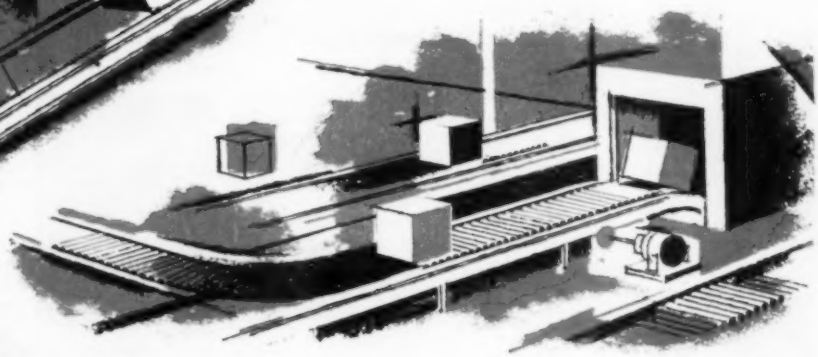

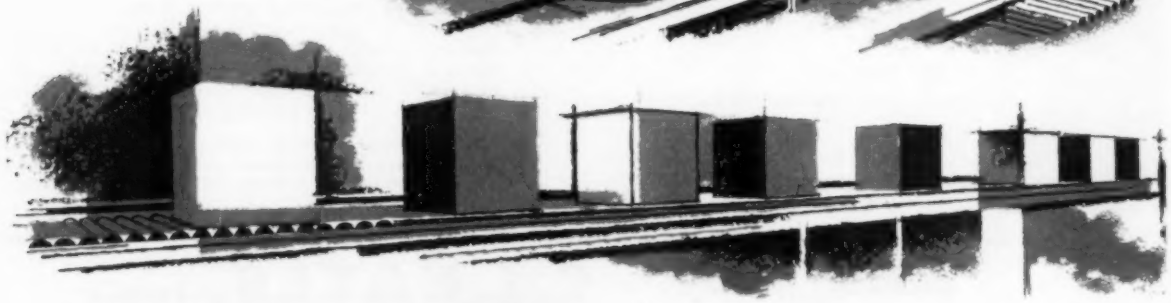

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Your customized procedures are developed on an extensive line of full-scale *production* heat treating equipment . . . not laboratory models. The equipment that goes into your plant is identical to that you *actually saw* meet your requirements. If models of proper size are not available, equipment will be tailored to your exact needs. Step 2 to RESULTS GUARANTEED!

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Free start-up service by a Hayes engineer completely familiar with the procedure developed assures duplication of laboratory results. Your staff is fully instructed on how to make the operation most economical and how to maintain the equipment for maximum life. Step 3 to RESULTS GUARANTEED!

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Hayes is known for its prompt, competent service . . . well aware that heat treating equipment is production equipment and that downtime is costly to the customer. Hayes maintains a private plane that speeds its Service Engineers to you when needed. Hayes is just as concerned about your equipment *after* you buy it as *before* you buy it. Step 4 to RESULTS GUARANTEED!

5 MAINTAINING OPTIMUM OPERATION . . .

Hayes maintains an extensive inventory of stock parts . . . your assurance that the equipment can be maintained in optimum operating condition long after competitive equipment has become obsolete or worn out. Because highest quality materials are used, less frequent rebuilds are required. Relatively few Hayes furnaces appear on the used-furnace market . . . proof that customers buy 'em, like 'em, hang on to 'em! Step 5 to RESULTS GUARANTEED!

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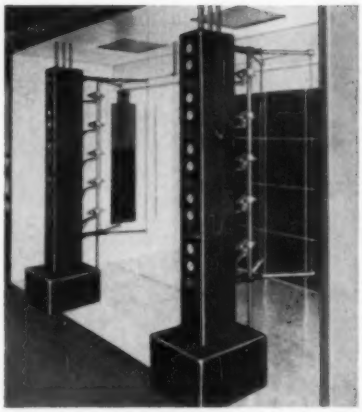
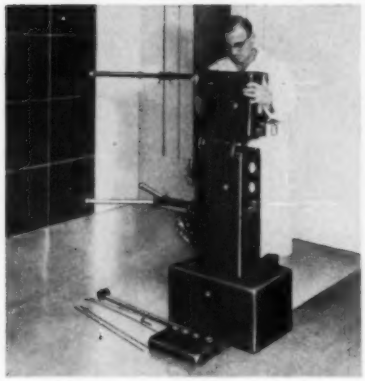
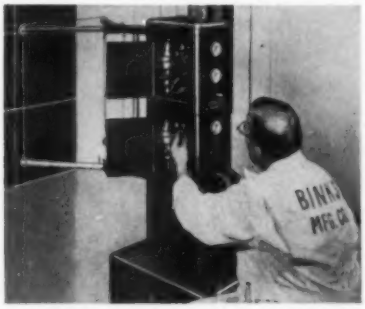
Circle 681 on Page 161

AUTOMATION new equipment

Machines and plant equipment for more automatic operations
For detailed information and literature, use card page 161.







Modular Spray System

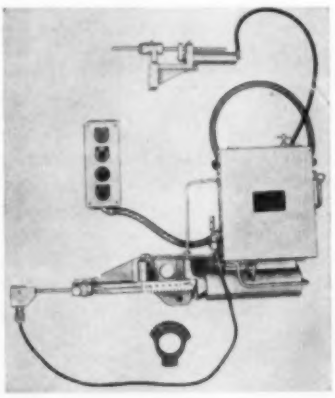
ELECTROSTATIC spray painting system is applicable to the painting of metallic products that can be handled on overhead conveyors or base-mounted conveyorized spindles. Principle of the system, which is designed by **Binks Mfg. Co.**, 3122 Carroll Ave., Chicago, Ill., is that the product acts to attract the paint. The metal object being painted is electrically grounded. As the paint leaves the automatic air atomizing spray gun, it receives a negative electrical charge, thereby creating in effect a positive-negative differential condition between the product and the paint globules.

The spray unit exhibits flexibility in that any number of spray guns can be mounted on a modular station, the choice depending on product specification or variety of shape. Left photo shows two 5-spray gun stations installed in a conventional dry-type filter spray booth. For a product with irregular surfaces, corners, and crevices, three or more modular units can be stacked to form a vertical gun control station, and the three guns aimed to cover the complete area.

Each modular unit has fluid and air pressure controls with regulator valves and hoses. The spray guns can be individually triggered for test spraying. Spray guns are mounted on a vertical plated rod which is equipped with two Y-shaped yokes, one above and one below the spray gun array. Each gun is adjustable up or down, right or left, on the rod. Center photo shows operator assembling second module to basic unit to form a 2-gun arrangement.

The instrument panel located at the rear of the unit houses the spray gun *Test* button. As shown in the right photo, any single gun can be operated manually for spray pattern, without disengaging other guns in the system. Model 21 operates on 100,000 v at 5 ma. maximum. A safety feature is that the entire system will shut off if a grounded object comes too close to the electrostatic grids.

Circle 401 on Page 161



Grinding Attachment

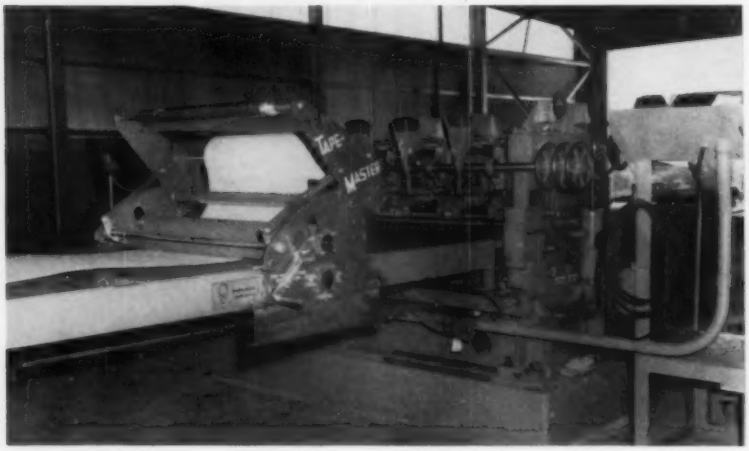
Item 402

Device is suitable for use on all centerless grinders. It cycles grinder infeed and returns to open position after ejecting the finished part. Attachment is equipped with variable position positive stop which is controlled by knurled sizing nut for removal of grinding stock from 0.00001 to as much as 0.040 in one grinding cycle or pass.

Control station consists of a *Stop* button, *Start* button, *Caution* pilot

light, and a selector switch for setup or automatic grinding positions. Control box has terminals wired for a limit switch which can be operated from automatic loading devices. Unit does not require hydrocheck to change feed rate when oil is cold. There is no checking of oil level or refilling of hydrocheck. Attachment is available in three different feed rates. Rapid feed up to the piece part, intermittent feed for faster and more efficient grinding, and a fine feed for rounding of the piece part and precise sizing against a positive stop controlled by a precision electronic timer. **Modern Devices, Subsidiary, 20th Century Mfg. Co.**, Box 429, Libertyville, Ill.

Circle 402 on Page 161



Automatic Tape Applicator

Item 403

Unit, designed for Norris Dispensers Inc., Hot Springs, Ark., manufacturers of milk dispensing equipment, is capable of automatically applying protective tape to stainless steel prior to fabrication. In operation, stainless steel in rolls is first fed through a straightener to relieve stress. The sheet then moves into the tape applicator, and as the tape is applied, the continuous sheet moves onto a humping table between the applicator and a shear. A measuring device automatically determines the length of the sheet and the shear cuts it off at the desired length.

The protective tape is fed from overhead roll-holders, through the applicating rollers, and is applied to the metal or plastic sheet under uniform pressure. Multiple rolls can be mounted at one time, permitting the application of different tapes or paper and tape in one continuous operation. Spot or intermittent taping can also be done in one operation. **Sod-Master Corp.**, 1023 NE Marshall, Minneapolis, Minn.

Circle 403 on Page 161

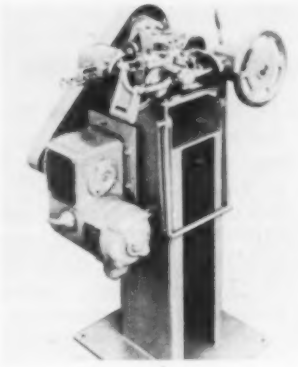
Bottle Neck Sealer

Item 404

Unit is capable of applying cellulose neck bands to bottles, is suitable for use in the beverage, food, chemical, and drug industries. In operation, bands are manually loaded in a vibrating magazine inclined at an angle so that gravity moves them against a vacuum block at the base. A geared indexing head carries band pick-up and applying mechanisms. While one band is removed from the magazine, another is applied on the neck of a bottle by the head unit 180 degrees away. The vacuum block is then raised, stripping the foremost band from the magazine, moving it where it can be speared by the pick-up mechanisms. As the head indexes, the band is opened, a mandrel inserted, and when it is directly over the bottle, the band is stripped off the mandrel, on to the bottle neck.

Machine can handle any type of glass which will travel upright, ranging in size from small vials to gallon jugs. Line speeds are adjustable up to 85 bottles per minute. Safety clutches on all bottle handling and band applying mechanisms stop the machine automatically in case of trouble. An available accessory is a bottle spotting unit which is attached on the intake end. It handles either recessed or extended-lug type glass, assuring exact alignment of the neck band with the bottle label or strip stamp. **Packaging Machinery Dept., Gisholt Machine Co.**, 1245 E. Washington Ave., Madison 10, Wis.

Circle 404 on Page 161



Wire Forming Machine

Item 405

Feature of Model 00, automatic 4-slide wire forming machine, is a vertical swing bed which permits raising the machine to vertical positions for tooling, adjustment, and maintenance. While in operation the horizontal position is used. The feed length is up to 4¼ inches, and tooling areas at each position enable production of a variety of small precision-formed parts. **Baird Machine Co.**, Stratford, Conn.

Circle 405 on Page 161

a compact, low-cost
INDICATING TEMPERATURE TRANSMITTER

green area is actual size silhouette of the new M/44

engineered for fast, sensitive response under roughest field conditions — uses any filled thermal system.

Here's a brand new instrument engineered specifically for its job of indicating and transmitting temperature.

The M/44 Indicating Temperature Transmitter offers the inherent simplicity of a motion balance instrument. Compact and lightweight (10 lbs.) its indicating scale and fluorescent red pointer are visible up to 20 feet away. The output pressure of the M/44 is transmitted to any remote 3-15 psi recorder, controller, or indicator.

The M/44 is made with standard performance-proved Foxboro components, simply and conveniently arranged in a weather proof steel case. Changing range or type of thermal system can easily be done in your own plant.

Thanks to its rugged construction, the new M/44 is unaffected by vibration, sudden shock, or corrosive atmosphere. Even in the event of air supply failure, this instrument continues to indicate process temperature.

Ask your Foxboro Field Engineer about this new instrument. Or write for Bulletin 13-28A, The Foxboro Company, 129 Norfolk St., Foxboro, Mass.

CHOICE OF THERMAL SYSTEMS

Foxboro M/44 Transmitters are available with any filled thermal system. These classes are suggested for particular range characteristics:

Class II Vapor Pressure (100° to 600°F)
Lowest cost, fastest response, highest sensitivity. Recommended for all installations within this range except when the measured temperature crosses ambient temperature.

Class IA & IB Liquid Expansion (−250° to +600° F)
Good response, good sensitivity, uniform scale. Uses smallest bulb of any filled thermal system.

Class III Gas Pressure (−450° to +1000° F)
Applicable to ranges beyond the limits of other filled systems. Uniform scale. Bulb has long sensitive section; permits useful averaging measurements.

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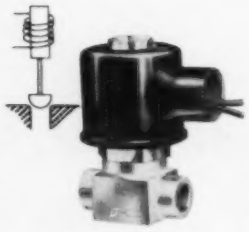
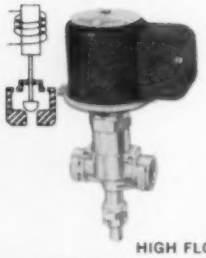
TEMPERATURE MEASUREMENT AND CONTROL

Circle 682 on Page 161

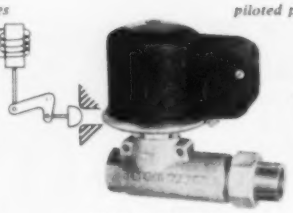
these six basic valves will meet any electric valve requirement you have



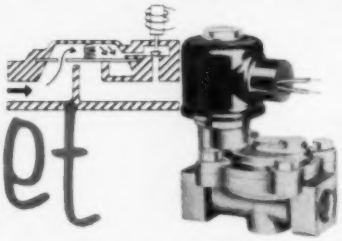
GENERAL PURPOSE
direct acting solenoid valves



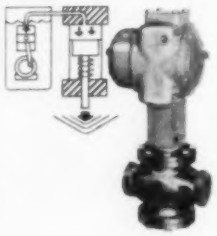
HIGH FLOW
piloted piston solenoid valves



HIGH PRESSURE
lever action solenoid valves



HIGH FLOW
magnetic diaphragm valves



HIGH VOLUME
HIGH PRESSURE
Hydramotor valves

HIGH POWER
Tork-Master valve operators

- normally open
- normally closed
- three-way
- four-way
- two-wire or three-wire control
- explosion-proof and weatherproof
- special body and seat materials
- odd voltages AC and DC
- UL, FM and AGA approvals

FROM 1/8" TO 60" PIPE SIZE

And with these GENERAL CONTROLS valves you get not only a complete range of sizes... but the right combination of operator *and* valve to do the job right... in terms of operating power, speed, capacity, flow characteristics and safety. You'll find the answer to your every electric valve problem in these GENERAL CONTROLS valves. Send for basic electric valve catalogs today.

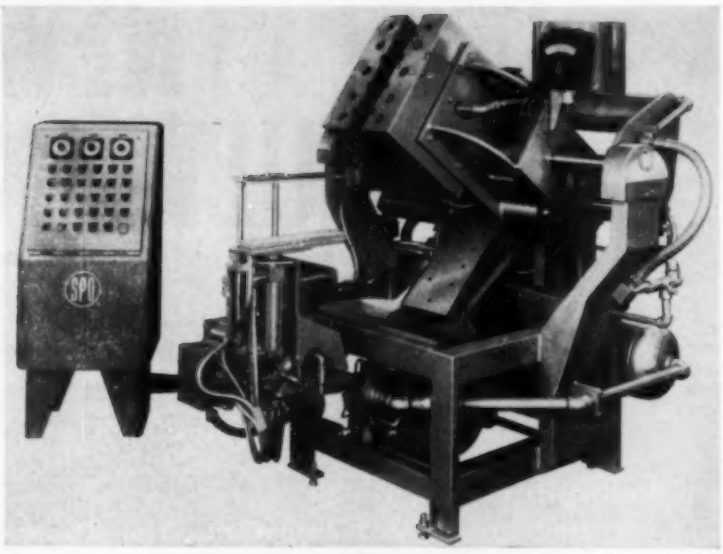
GENERAL CONTROLS

Manufacturers of America's Finest Automatic Controls for Home, Industry and the Military

Glendale, Calif. • Skokie, Ill. • Guelph, Ontario, Canada

Six Plants—42 factory branch offices serving the United States and Canada

Circle 683 on Page 161

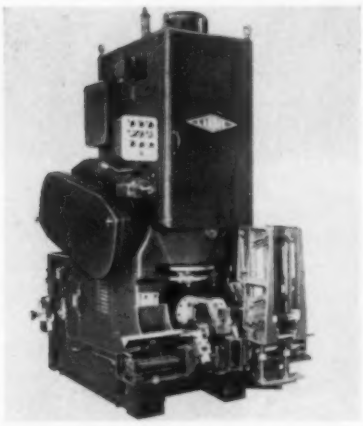


Sand Molding Machine

Item 406

Suitable for a variety of hollow cores and shell molds where mixed types and sizes are blown simultaneously, Model SC-30 provides exact selection of cycle times and temperatures. Machine can accommodate core boxes from 3 to 9 inches thick, 1 to 16 inches deep and 5 to 21 inches high. A method called *Angle-Blo* gives uniform wall thickness and provides complete drainage of horizontal arms. With this method, the core box is blown at a 45 degree angle and rotates through an 80 degree arc to drain uncured sand. The sand system is continuous and automatic; all uncured sand is screened prior to draining back into the sand magazine. Additional equipment available includes an automatic unloader which removes cores and deposits them on a delivery conveyor, electrically heated ovens, thermostatic oven heat control and automatic core box sprays. **SPO Inc.**, 7500 Grand Division Ave., Cleveland 25, Ohio.

Circle 406 on Page 161



Coupling Tapper

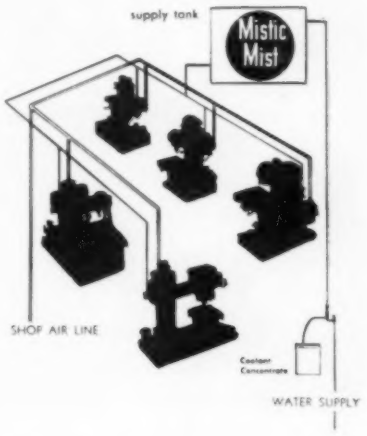
Item 407

Automatic coupling tapping machine is adaptable for the high production precision internal threading of oil tubular and commercial couplings ranging from 2⅞-inch drill pipe external upset to 9⅝-inch long thread casing couplings. Production rates range from fifty-six 3½-inch line pipe couplings tapped at 37 sfm to eleven 9⅝-inch long thread casing couplings threaded at 27 sfm. When using an ac constant speed motor, ten spindle speeds, ranging from 7 to 56.8 rpm can be obtained by changing the vee belt drive pulleys. Variable speed mechanical and dc motor drives are available.

In operation, a transfer mechanism moves the coupling from the bottom of a magazine along slide plates into a chuck. An automatic workstop assures correct positioning of the workpiece. Grips close and the chuck moves rearward to the tapping area. It then indexes 90 degrees to bring the coupling into tapping position for the first end. The spindle and tap head unit lowers to perform the threading operation. The lead screw nuts engage, coolant is automatically supplied, and the tap trip-ring contacts the coupling face. Tap collapsing then occurs, and this action opens the lead screw nuts, stops the coolant flow, and returns the spindle to its uppermost position. The chuck is indexed 180 degrees and the second end of the coupling is tapped. At the completion of this operation, the grips open and the entire cycle repeats with the completed coupling being expelled from the chuck by the one being loaded.

Features of the machine include a receding chaser-tap mechanism to assure threads of positive and precision taper with infinite settings, detachable tape heads for wide range coverage, and variable spindle float to maintain alignment between the tap and the chucked coupling. **Landis Machine Co.**, Church & Fifth Sts., Waynesboro, Pa.

Circle 407 on Page 161

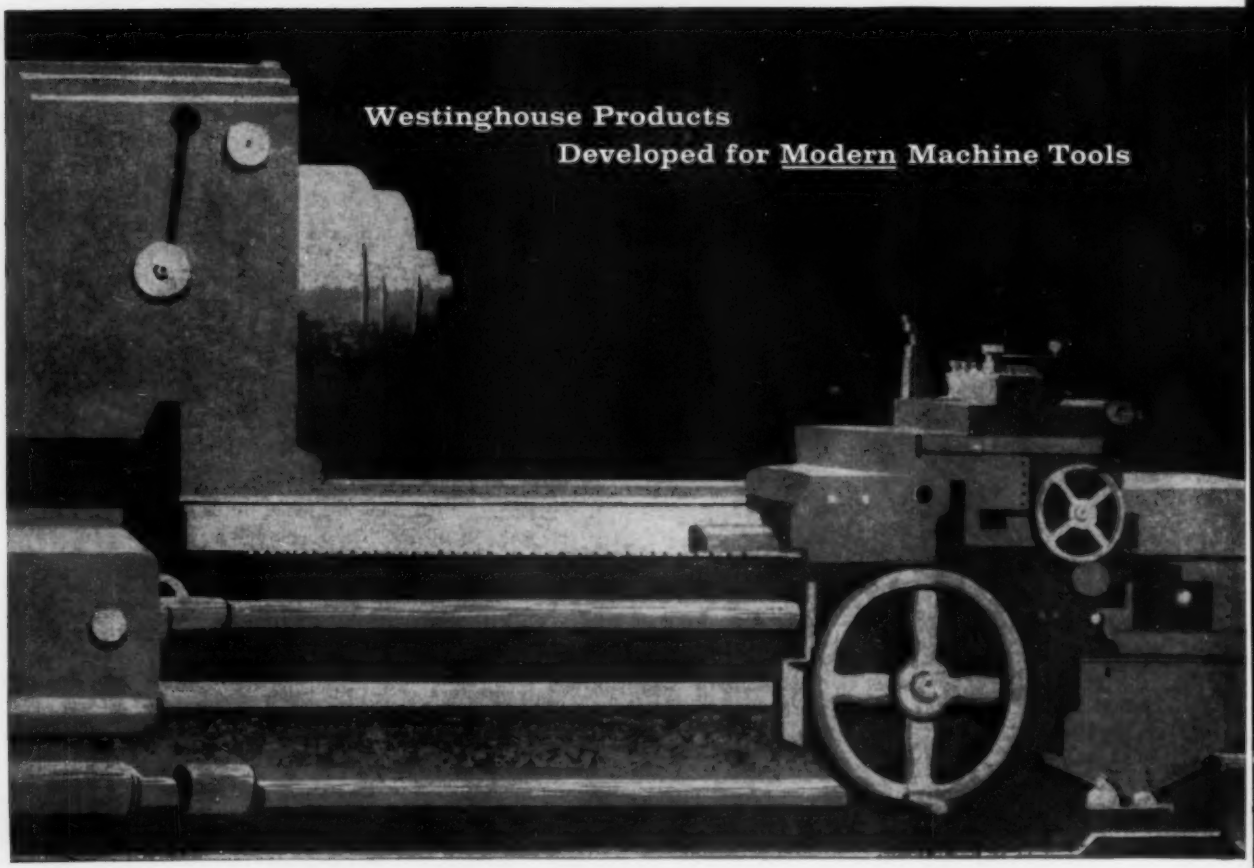


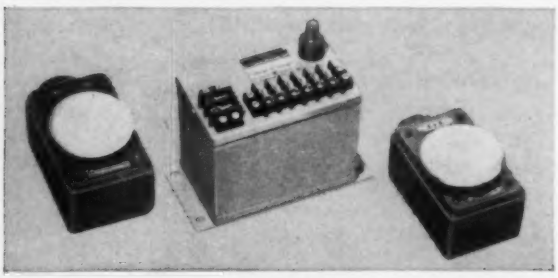
Mist Coolant System

Item 408

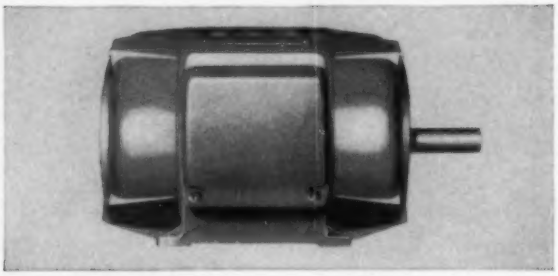
System uses principle of gravity feed to supply premixed coolant to any number of machines from a single supply source. Individual control valves are mounted on each machine, can be used singly or in banks for automatic or manual control. The injector valve on the water supply line permits supply tank refill from floor level. The ratio of the mixture is governed by the size of the supply tank and the

NEW NULTRAX ACCURATE TO





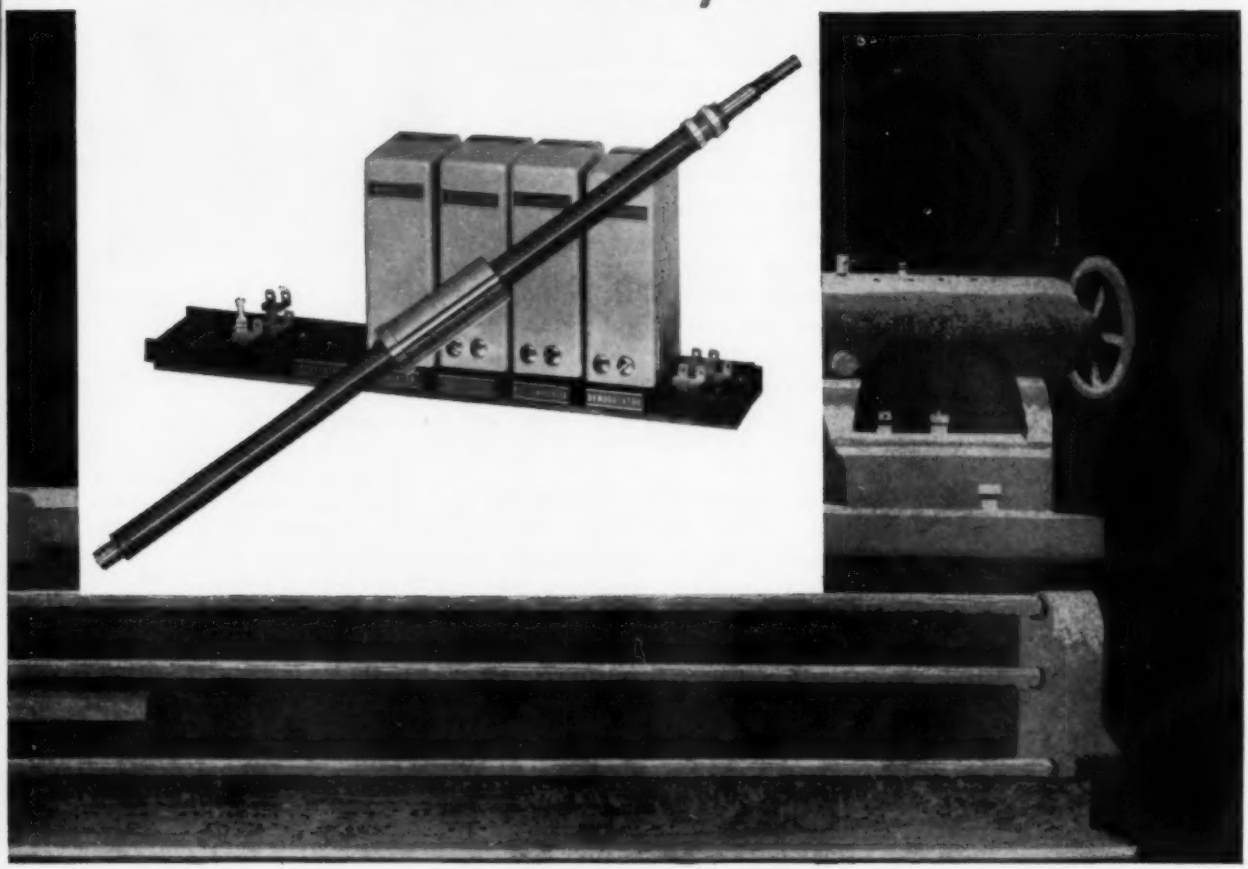
New Westinghouse Cypak® Dual Safety Interlock is a highly reliable, anti-repeat safety device for punch press operation —completely static; no moving parts, contacts or tubes to wear or burn out.



Westinghouse Life-Line® "*A*" a-c motor, the industry standard, combines Bondar®, Bondite and Mylar* insulation for long life. Prelubricated, factory sealed bearings eliminate need for lubrication—keep lubricants in, dirt out.

*Du Pont registered trademark

WESTINGHOUSE CONTROL 1 PART IN 100,000



Unaffected by wear and free from backlash, NULTRAX linear positioning system makes possible the measurement of linear displacement on one or more axes to accuracies of one hundred thousandth of its full range of travel, which may extend over distances of many feet. NULTRAX and other Westinghouse numerical control systems are available to cover the complete range of production accuracies.

Positioning systems are another example of Westinghouse products—the sign of a modern machine tool designed to give the most production at the lowest possible cost. A coordinated electrical system, designed and supplied by Westinghouse industry-experienced engineers, is sure to give the best in long-term economical service.

For complete information about NULTRAX and other Westinghouse POWER-UP products for modern machine tools, ask your Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-96112

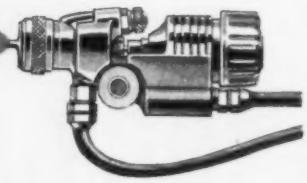
YOU CAN BE **SURE**...IF IT'S

Westinghouse

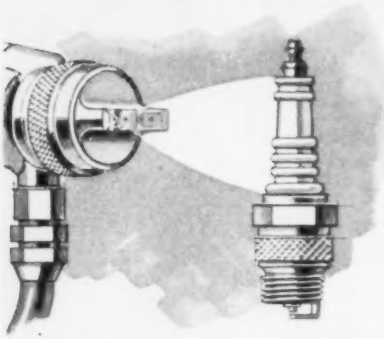
Circle 684 on Page 161

They solved it with...

AUTOMATIC SPRAY



9600 spark plugs per hour are glazed automatically by an Ohio spark-plug manufacturer. The installation of a pair of DeVilbiss Automatic Chain-On-Edge Machines has resulted in valuable economies for this company. Not only are the usual savings of time, labor and reduction in waste materials gained; but, more significant, the operation is exceptionally simple, trouble-free, and easy to adjust and maintain. Finished plugs are of a more uniform quality than ever, too.



* *

Now you can have your cake at the rate of 80 per minute thanks to a DeVilbiss installation for an Illinois cake-mix manufacturer. Previously, the glassine inserts tended to collapse as they were forced into the packages by compressed air. DeVilbiss spray guns on the conveyor now puff-spray a fast-setting adhesive to a small area inside each box, keeping the inserts in place. The entire operation is automatic; and a bothersome problem has been eliminated.

* * *

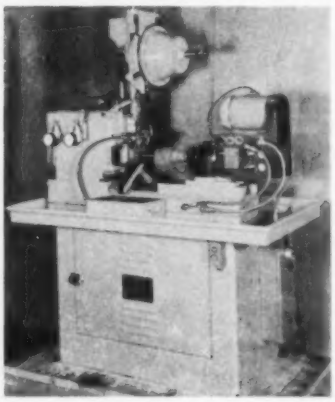
Have *you* a coating problem? Let DeVilbiss research experts determine whether or not it can be automated. DeVilbiss spray equipment is designed to meet *your* specifications and more than likely will save you time and money. Won't you call or write us? *The DeVilbiss Company, Toledo 1, Ohio; Barrie, Ontario; London, England. Branch offices in principal cities.*

FOR BETTER SERVICE, BUY
DEVILBISS

Circle 685 on Page 161

amount of concentrate dilution. A variety of nozzle leads, including steel mesh covered, plastic or copper tubing, and flexible cable, are available. **Aetna Mfg. Co.**, Bensenville, Ill.

Circle 408 on Page 161



Item 409

Drilling/Tapping Unit

Automatic hopper-fed drilling or tapping machine accurately positions and holds rivets or other headed parts for operations such as drilling or tapping. The heads of the work are clamped axially, eliminating the possibility of misalignment that could cause the tool to weld to the workpiece. Model 409 can tap to within 1/16-inch of the bottom of blind holes. Spindle *Advance* and *Retract* motions are controlled by knobs. Spindle speeds can be changed over a wide range. The hopper (Model 618) is adjustable, has radially slotted rings which are interchangeable. **Batchelder Engineering Co. Inc.**, 125 Main St., Springfield, Vt.

Circle 409 on Page 161

Item 410

Grinder/Lapper

Machine combines lapping and grinding operations. It is suitable for any flat or surface ground parts for degrees of finish from 32 to 1 microinch rms and flatness from 0.010 to 0.000002-inch. Because of the loose grit method used, parts can be processed in the as-cast, sintered, stamped, or turned condition. Model 32 can handle either rough or finish work on a variety

At the Brussel's Fair IBM's Ramac presents World History in 10 languages with the help of Skinner Solenoid Valves

Visitors to the World's Fair at Brussels are given the opportunity to submit history questions to IBM's Ramac and get their answers in any one of ten languages. Millions have been fascinated by this amazing electronic data processing machine.

Ramac is a vast library of facts. By means of 50 rotating metal disks 5,000,000 alphamerical characters can be stored and selected at the touch of a button. The Ramac can punch 100 cards a minute, transfer data from punch cards to disks at a rate of 125 cards per minute, and print reports at speeds up to 80 lines per minute.

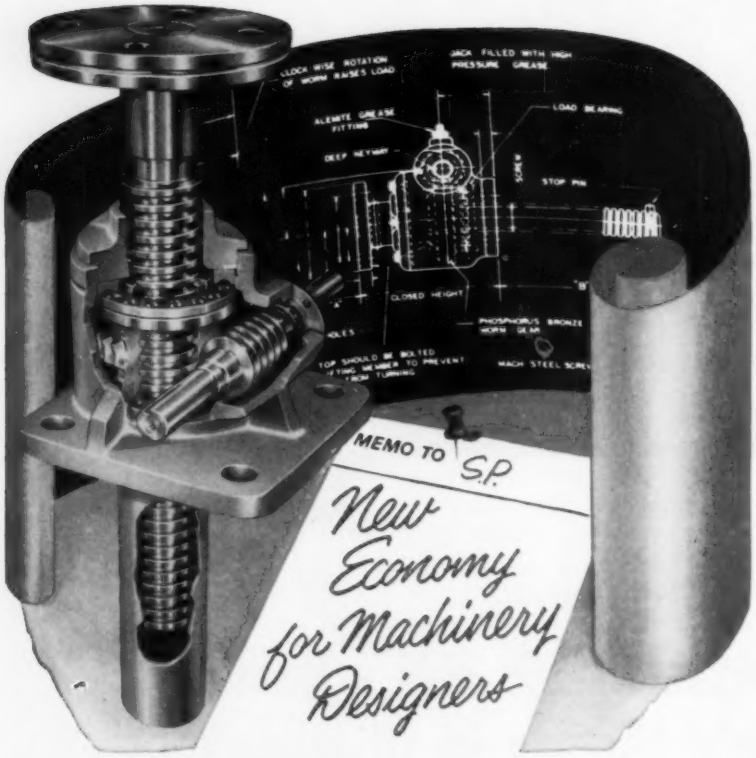
Three Skinner V5 three-way valves are used in the access control mechanism. One valve engages the access arm at the exact location of the disk, while the second valve disengages the arm after the read-write sequence has been completed. The third valve positions the read-write head at the precise location on the proper disk tract.

Skinner has a wide selection of solenoid valves for all types of applications. If you have a control problem, why not take it to a Skinner engineer or representative. You will find Skinner representatives listed in the Yellow Pages or write direct to Department 329.

SKINNER ELECTRIC VALVES
THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
105 EDGEWOOD AVENUE

Circle 686 on Page 161



NOW, A STANDARD LINE OF DUFF-NORTON WORM GEAR JACKS

The economies of standardized production now can be realized by machinery designers who use Duff-Norton worm gear jacks for accurate positioning of loads weighing as much as several hundred tons. After 25 years of experience and hundreds of custom designs, Duff-Norton engineers have produced a standard line of eight jacks ranging from 2 to 100 tons in capacity which will meet almost any requirements. When jacks are used in an arrangement, added economy can be realized in raising unevenly distributed loads, since all models now have a uniform raise which permits jacks of varying capacities to operate in unison.

Worm gear jacks are purely mechanical devices, and they can hold heavy loads in position indefinitely without any creep. Functioning as components of machinery or equipment, they can raise or lower loads, apply pressure or resist impact. Worm gear jacks can be furnished with raises up to 24 inches, and they will provide exactly the same raise for years without adjustment.

Thousands of these jacks are in use on feeding tables, tube mills, welding positioners, pipe cut-off and threading machines, testing equipment, aircraft jigs, loading platforms, rolling mills, conveyor lines, and numerous other types of equipment. If you have a positioning problem, write for complete information, requesting Bulletin AD-66-GG, which includes drawings and full specifications.

DUFF-NORTON COMPANY

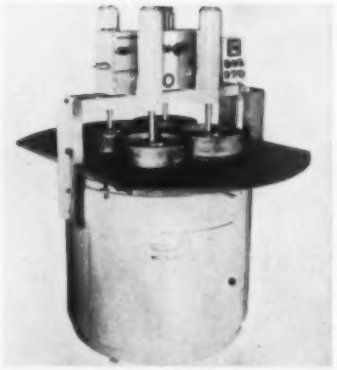
P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION • Danville, Illinois

DUFF-NORTON JACKS
Ratchet, Screw,
Hydraulic, Worm Gear

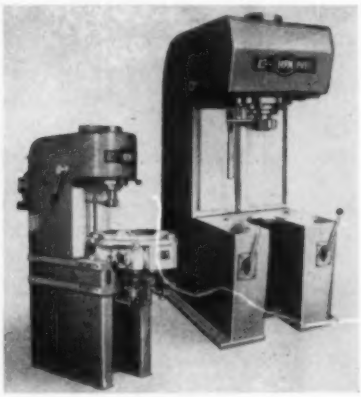
DUFF-NORTON

COFFING HOISTS
Ratchet Lever
Spur Gear, Electric



of materials including carbides, steels, ceramics, and plastics. A steel alloy plate is used with an abrasive media to effect sizing of parts without distortion, heat cracks, or burrs. **Abrading Systems Co.**, 8020 N. Monticello Ave., Skokie, Ill.

Circle 410 on Page 161



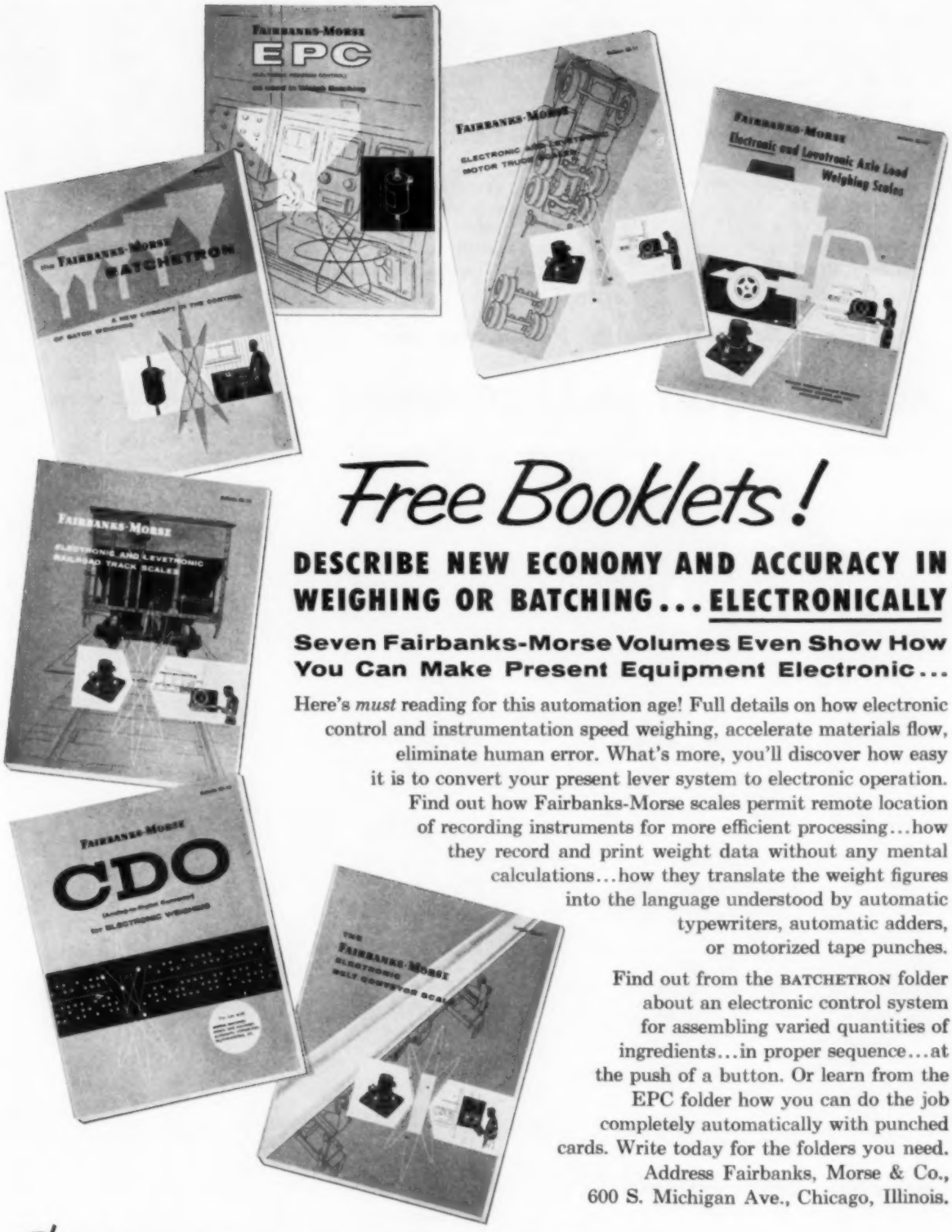
Hydraulic Presses

Item 411

Machines are applicable for operations such as forming, drawing, broaching, trimming, staking, embossing, bending, marking, burnishing, crimping, coining, straightening, and assembling. Line of hydraulic C-frame presses is available in dual lever manual (shown right) and automatic types. The basic automatic model provides controls for either single or automatic cycle, and ram reversal to either distance or pressure settings. A positive ram guide provides accurate positioning of the ram so the alignment of tooling is held to close tolerances.

The second automatic model (shown left), in addition to features of the basic unit, also includes control elements for a hydraulic interlock index table. The index table

Circle 687 on Page 161



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Seven Fairbanks-Morse Volumes Even Show How You Can Make Present Equipment Electronic...

Here's *must* reading for this automation age! Full details on how electronic control and instrumentation speed weighing, accelerate materials flow, eliminate human error. What's more, you'll discover how easy it is to convert your present lever system to electronic operation. Find out how Fairbanks-Morse scales permit remote location of recording instruments for more efficient processing...how they record and print weight data without any mental calculations...how they translate the weight figures into the language understood by automatic typewriters, automatic adders, or motorized tape punches.

Find out from the BATCHETRON folder about an electronic control system for assembling varied quantities of ingredients...in proper sequence...at the push of a button. Or learn from the EPC folder how you can do the job completely automatically with punched cards. Write today for the folders you need. Address Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago, Illinois.

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has a work circle diameter of 16 inches, with either, 6, 8, or 12 stops for the mounting of tooling. It is capable of carrying a full work load of 100 lb at speeds to 80 indexes per minute. The index table is operated by an acceleration and deceleration barrel cam, can accurately position work carriers beneath the ram within 0.002 inches. Table speed is infinitely variable, controlled by a valve control. Design of the table permits ejection cylinders or other tooling elements to be directly mounted to the housing beneath the table dial. **Hydraulic Press Mfg. Co., Div., Koehring Co.**, Mt. Gilead, Ohio.

Circle 411 on Page 161

Induction Heating Lines

Item 412

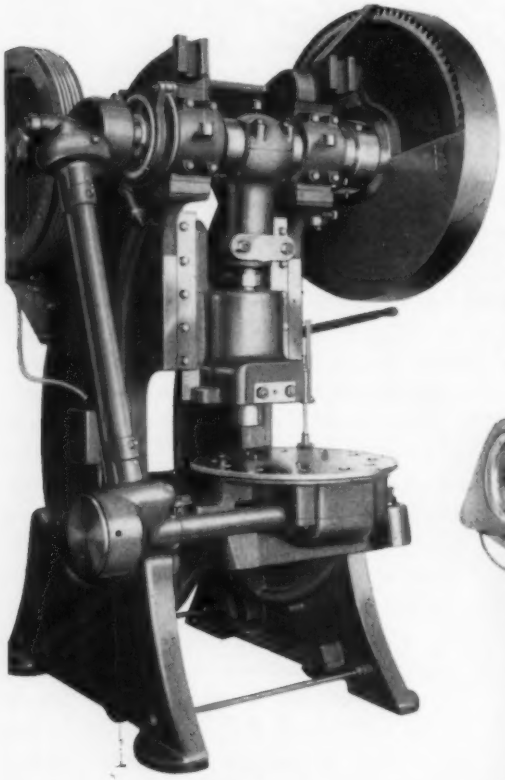
Equipment is applicable in operations such as heat treating, hardening, billet preheating, and ingot breakdown, as well as joining operations such as brazing and soldering. Three frequency ranges are available: Low frequency 1-10 kilocycles, 7½-1750 kw, motor-generator powered; medium frequency 450 kilocycles, 3-50 kw electronic-generator equipped; and high frequency 27.1 megacycles, ¾-20 kw electronic-generator equipped. Units can be furnished with automatic parts handling and feeding systems. **Robotron Corp.**, 21300 W. Eight Mile Rd., Detroit 19, Mich.

Circle 412 on Page 161

Modern FEDERAL Dial Feeds give you

automation at less cost!

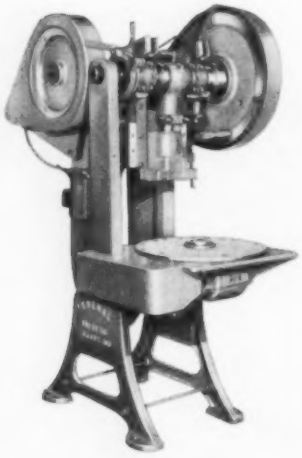
—eliminate specialized and more costly equipment!



No. 7 Dial Feed
Gear Driven. Capacity, 80 tons.

Federal Dial Feeds are your answer to greater production at lower costs. Equipped with special jigging, automatic feeds and ejectors, their applications are virtually unlimited and the need for specialized, more costly equipment often eliminated. (Example, one manufacturer increased production 600%.)

Add Federal's quality features and workmanship . . . and you've got a winner. Investigate Federal Dial Feeds for your operations. Gear or chain driven with cam-type indexing mechanisms. Sizes range from 6 to 80 tons.



No. 3 Dial Feed
Chain Driven. Capacity, 26 tons.

FEDERAL PRESS COMPANY
802 Division St., Elkhart, Indiana

FEDERAL DIAL FEED PRESSES
33 Years' Experience in Dial Feed Engineering and Construction

Threaded Insert Unit

Item 413

Assembly machine includes a vibratory feed hopper, an orienting unit, and an air operated ram. It can be adapted to existing setups such as arbor presses or foot presses. The machine places the inserts into drilled or molded holes and anchors the inserts at the same time. Production rate is as high as 72 per minute on a single punch machine. Where more than one insert is used in a workpiece, the unit can be tooled to place and expand as many as six inserts at a time. **Phelps Mfg. Co.**, P.O. Box 542, Westport, Conn.

Circle 413 on Page 161

Circle 689 on Page 161

TYPICAL SCHRADER SIMPLIFIED VALVE DESIGN

. . another reason why your air system installations will perform best.

A—Mounting holes always conveniently located.

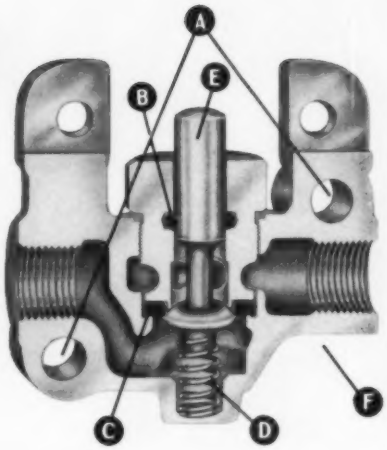
B—"O" rings used for surest airtight seal.

C—Oil-resistant synthetic rubber used in washers for positive leakproof seat.

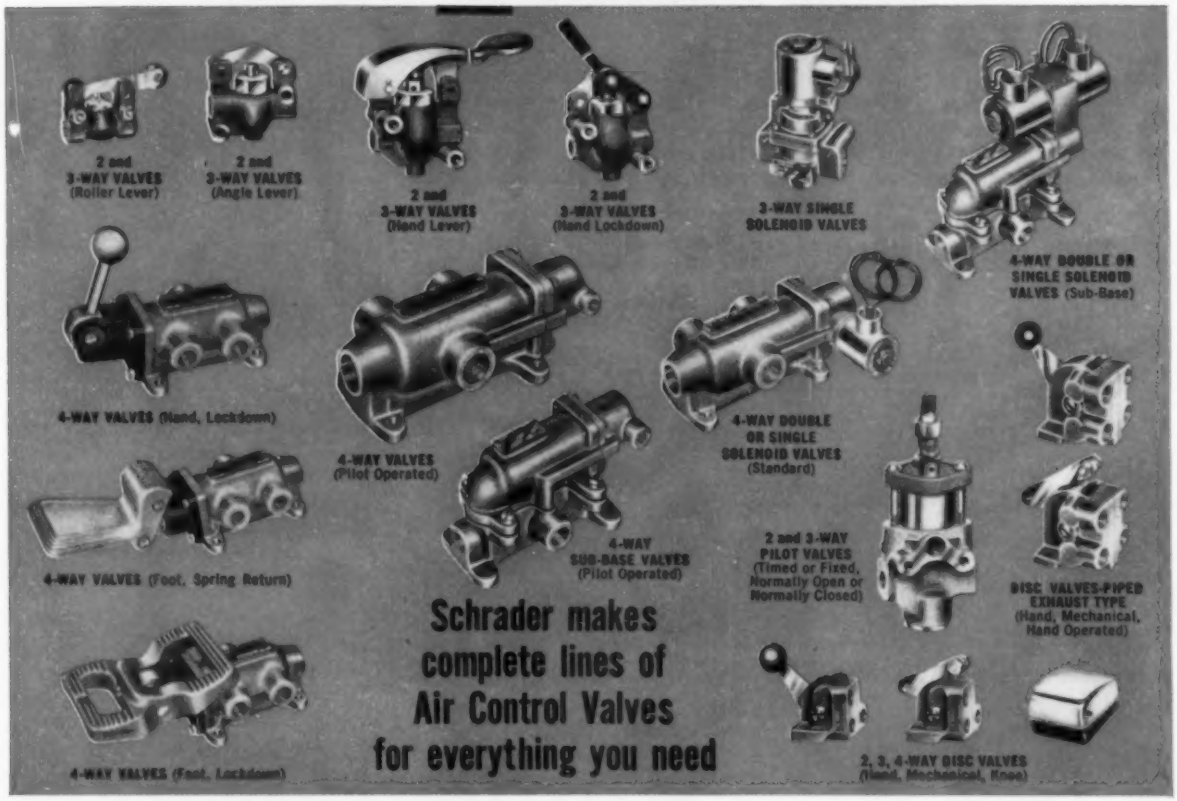
D—Stainless steel springs: rust resistance, longest service life.

E—Sturdy plated plungers, quick acting, smooth-operating.

F—All parts designed for greatest air flow, longest life and simplicity of replacement and interchangeability.



INSIDE EVERY SCHRADER VALVE YOU CAN SEE SCHRADER QUALITY


2 and 3-WAY VALVES (Roller Lever)
2 and 3-WAY VALVES (Angle Lever)
2 and 3-WAY VALVES (Hand Lever)
2 and 3-WAY VALVES (Hand Lockdown)
3-WAY SINGLE SOLENOID VALVES
4-WAY DOUBLE OR SINGLE SOLENOID VALVES (Sub-Base)
4-WAY VALVES (Hand, Lockdown)
4-WAY VALVES (Pilot Operated)
4-WAY DOUBLE OR SINGLE SOLENOID VALVES (Standard)
4-WAY VALVES (Foot, Spring Return)
4-WAY SUB-BASE VALVES (Pilot Operated)
2 and 3-WAY PILOT VALVES (Timed or Fixed, Normally Open or Normally Closed)
DISC VALVES-PIPED EXHAUST TYPE (Hand, Mechanical, Hand Operated)
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4-WAY VALVES (Foot, Lockdown)
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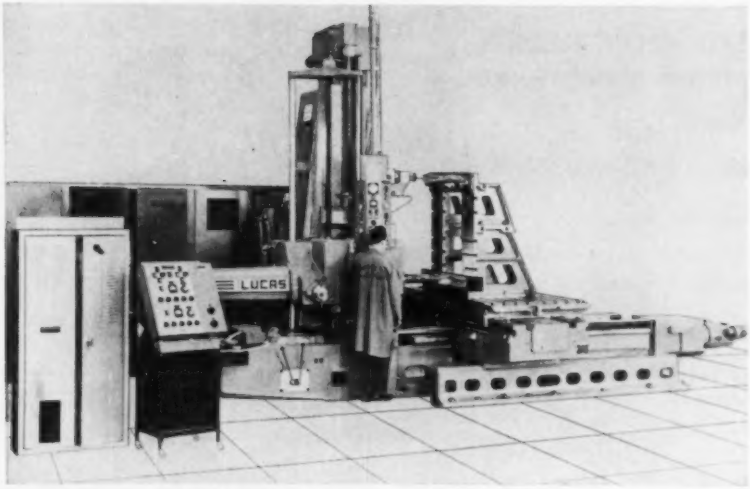
QUALITY AIR CONTROL PRODUCTS

Circle 702 on Page 161



Program-Controlled Machine Tool

Item 414

Equipment can be used as an automatic program-controlled machine or as a standard boring, milling, and drilling machine. It can be furnished with tracer equipment, numerical positioning equipment (punched tape) or numerical contouring equipment (magnetic tape). Tracer-controlled machines have either one-dimensional, two-dimensional, selective two-dimensional, or three-dimensional tracer equipment with various tracing speed ranges available.

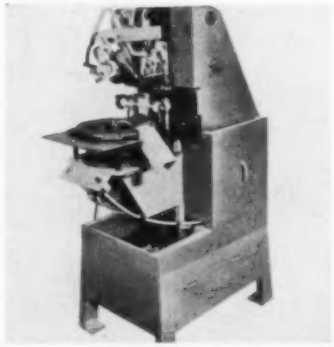
The numerical position control can be furnished for as many as six motions to control the head, table, saddle, horizontal rotary table, vertical rotary table, and spindle feed. Data input is provided by manually-set decade switches or punched tape. **Lucas Machine Div., New Britain Machine Co.**, 12302 Kirby Ave., Cleveland 8, Ohio.

Circle 414 on Page 161

Product Marker

Item 415

Machine is suitable for marking specifications and trademarks on tubular and flat capacitors with right-angle wire leads. The capacitors are fed, two at a time, into work holder pockets. An air operated dial automatically indexes to the printing position where the units are marked and then ejected.



Machine cycles 30 times per minute, giving a production rate of 60 units per minute. Interchangeable 8-station dial plates accommodate various sizes of capacitors. Model 92A is also capable of imprinting other electrical components, such as limit switches or pieces with uneven shapes or surfaces. **Markem Machine Co.**, Keene 66, N. H.

Circle 415 on Page 161

NOW! WAREHOUSING, Too, Becomes AUTOMATIC!

..with an A-F ENGINEERED CONVEYING SYSTEM

Take a good look at *your* warehouse! Chances are, it offers possibilities for *big savings* by replacing intermittent, old-fashioned handling methods with an efficient, *continuous-flow* A-F *Engineered* Conveying System.

With such an A-F Conveying System, items can be collected from various locations, identified and routed to the proper storage conveying lines—then selected orders are dispatched to designated shipping docks—*all automatically!*

Whatever your requirements, A-F can *engineer* the *proper* type of conveying system for both your *plant* and your *warehouse.* Write us—without obligation—today.

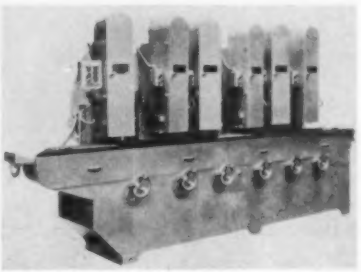
YOU CAN SEE THE SUPERIORITY OF A-F CONVEYOR ENGINEERING

A-F

A-F *ENGINEERED* CONVEYING SYSTEMS

Also Pre-Engineered Conveyors—
Wheel, Trolley, Roller, Belt
Metal Cleaning and Processing Machines

THE ALVEY-FERGUSON CO., 173 Disney St., **CINCINNATI 9, OHIO** and Azusa, California



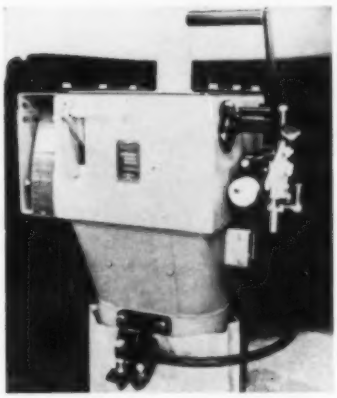
Conveyor Belt Grinder

Item 416

Machine is adaptable for high-volume flat surfacing of ferrous and nonferrous metals, glass, plastics,

and ceramics; can perform six grinding operations in a single conveyorized pass. Model 680-6 is equipped with six individually adjustable grinding heads. A series of progressively finer grit abrasive belts provide the unmachined parts to be rough-ground, precision-sized, and machined to a fine, micro-inch finish in one continuous operation. For parts needing heavy stock removal, identical belts can be used on each grinding head to multiply production rates. Unit is designed for both wet and dry-belt grinding. A self-contained cooling system is powered by two ½ hp coolant pumps. Maximum piece capacity is 5 inches high, 5½ inches wide, and any length. Conveyor belt is 7 inches wide by 268 inches long; the abrasive belt speed is 5500 sfpm. **Engelberg Huller Co.**, 831 W. Fayette St., Syracuse 4, N. Y.

Circle 416 on Page 161

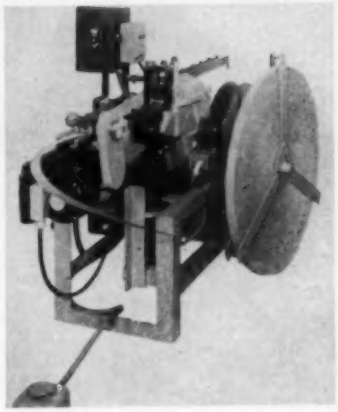


Gross Bagger

Item 417

Unit can weigh and bag free-flowing material such as abrasives, chemicals, plastics, soaps, and powders. Model G-17, which is designed to fill bags ranging in capacities from 10 to 140 lb, features a trigger arrangement with an automatic cut-off. The trigger arrangement holds the gate open a maximum time, and in many cases allows the trigger to be set for the exact weight desired. Unit also has a cam-grip bag holder, for fast release of the bag, and a slide mounting which permits serving of multiple spouts. **Richardson Scale Co.**, Van Houten Ave., Clifton, N. J.

Circle 417 on Page 161



Feeder Attachment

Item 418

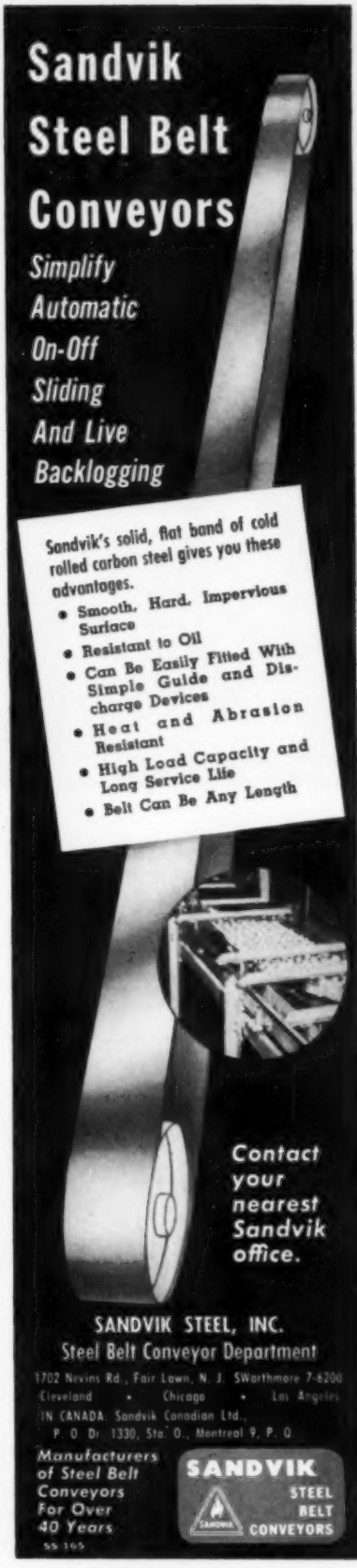
Paper feeder attachment is adaptable to all company power strapping machines. Unit feeds a chipboard paper strip under the strapping; is suitable for use in strapping small bundles or packages which require additional protection. Paper feed mechanism consists of a supply roll, a guide, and a powered feeder. In operation, both the strap and paper feed are timed. A switch on the timer allows a predetermined amount of strapping to be fed with the paper. Where the amount of strap fed is controlled by a foot pedal, the amount of paper fed can be controlled by the same pedal. The supply roll of Model SPD-182 holds 22 pounds or about 15,000 feet of 1¼-inch wide chipboard strip. **Signode Steel Strapping Co.**, 2600 N. Western Ave., Chicago 47, Ill.

Circle 418 on Page 161

Stator Winder

Item 419

Machine is designed for winding wire from 24 to 40-gage, has an


Sandvik
Steel Belt
Conveyors
Simplify
Automatic
On-Off
Sliding
And Live
Backlogging
Sandvik's solid, flat band of cold rolled carbon steel gives you these advantages.
• Smooth, Hard, Impervious Surface
• Resistant to Oil
• Can Be Easily Fitted With Simple Guide and Discharge Devices
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• High Load Capacity and Long Service Life
• Belt Can Be Any Length
Contact your nearest Sandvik office.
SANDVIK STEEL, INC.
Steel Belt Conveyor Department
1702 Nevins Rd., Fair Lawn, N. J. SWarthmore 7-6200
Cleveland • Chicago • Los Angeles
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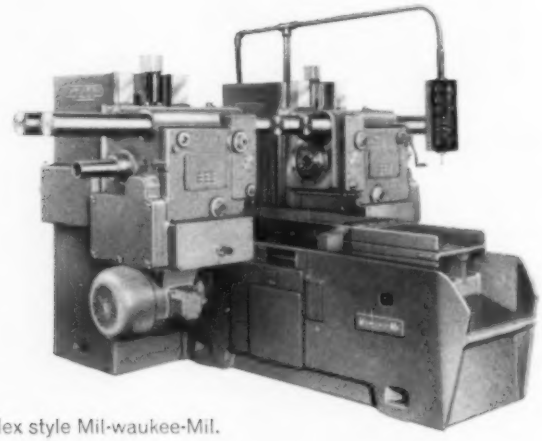
Manufacturers of Steel Belt Conveyors For Over 40 Years
SS-165
SANDVIK
STEEL
BELT
CONVEYORS

Circle 692 on Page 161

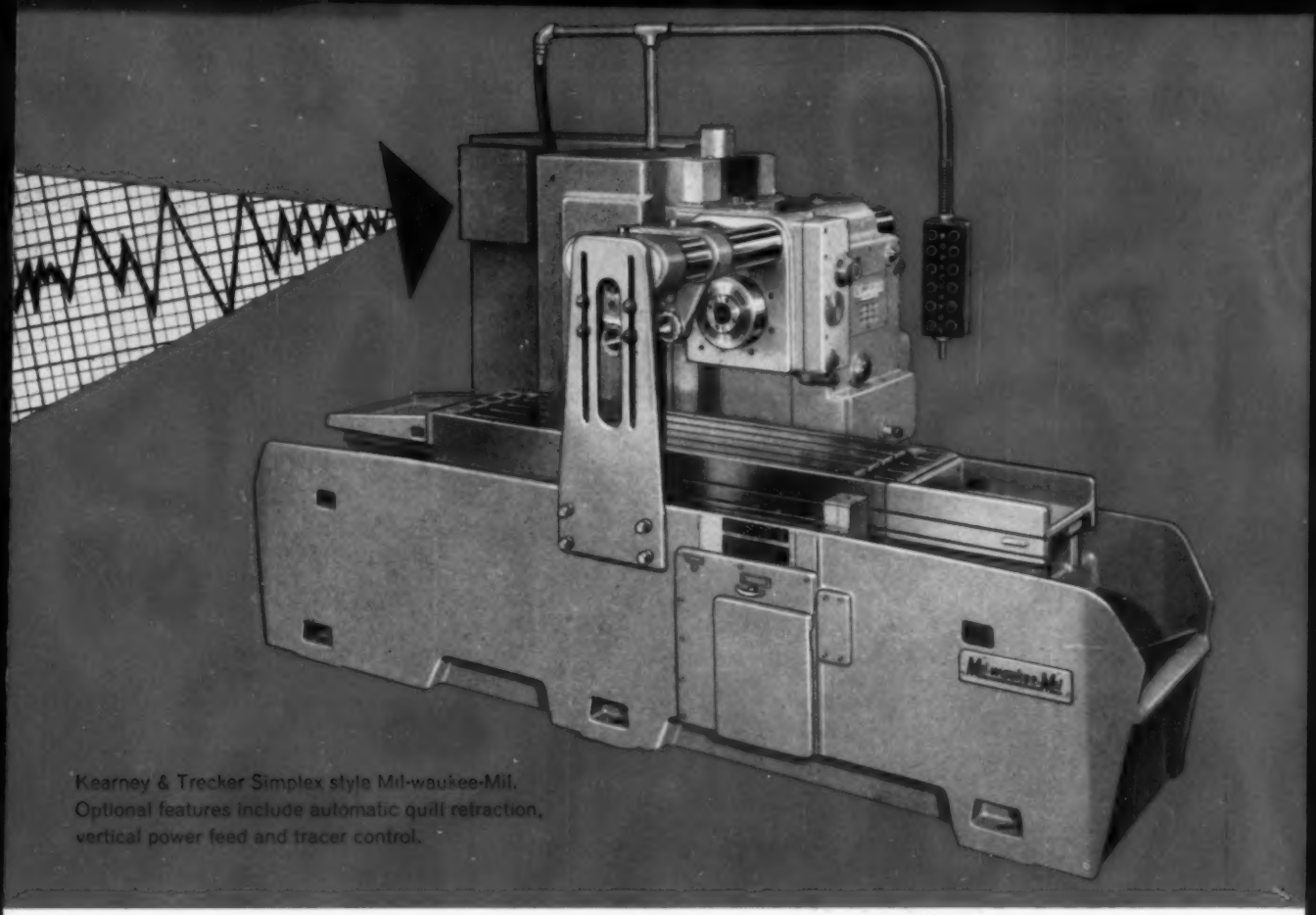
first ***dial*** *your results from the blueprint . . .*



Kearney & Trecker Duplex style Mil-waukee-Mil.

Designers and Builders of Precision and Production Machine Tools Since 1898

KEARNEY & TRECKER MILWAUKEE ®



Kearney & Trecker Simplex style Mil-waukee-Mil. Optional features include automatic quill retraction, vertical power feed and tracer control.

then get programmed production ***automatically***
with the NEW ***Kearney & Trecker***

Mil-waukee-Mil® BED TYPE

PRODUCTION MILLING MACHINE

- ***dial-a-cycle*** **panel programs and controls each and every machine function . . . automatically!**
- **Interrupt or resume cycles at any time without returning to "start" position!**
- **Change from *dial-a-cycle* automatic control to manual with the flip of a switch!**
- **Choose from 72 standard models . . . Simplex and Duplex . . . 7½ to 30 hp.**

Fast, pre-phased setups slash idle cutter time — dramatically boost finished workpiece production. Do it on this remarkable new Kearney & Trecker Mil-waukee-Mil programmed production milling machine.

Operator simply dial-programs machine function into the ***dial-a-cycle*** control panel. No guesswork! He merely reads workpiece blueprint and establishes machining sequence with successive phase-switch dials.

Free Bulletin MM-58 —

Kearney & Trecker Corp., 6784 West National Ave., Milwaukee 14, Wisconsin.

Circle 693 on Page 161

operating speed of up to 1000 turns per minute. On a two-pole, universal type stator with 200 turns per pole, it will wind as many as 175 stators per hour. Unit is adaptable to various winding requirements; simultaneous type for winding all poles at one time, simultaneous type with automatic tap-pulling attachment for multispeed motors, full index for series wound stators, and partial index and return for series wound stators. It can handle stators having lamination stack heights up to 1½-inch, depending on configuration of the stator.

Features of the winder include a predetermining count-type counter with automatic reset adjustable from 1 to 2000 turns, an automatic lead cutoff with receiving nest, and a winding head positioner which causes the winding head to stop in the same position at the end of each cycle. **Fort Wayne Tool, Die & Engineering Co.**, Fort Wayne, Ind.

Circle 419 on Page 161

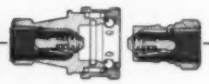
Wherever 2-way shut-off is required...

HERE'S THE COUPLING FOR THE JOB

HANSEN

SERIES HK®

TWO-WAY SHUT-OFF COUPLING



Shuts off both sides of line... prevents loss of liquid, gas or pressure

WRITE FOR THE HANSEN CATALOG

Here's an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings—including Special Service Couplings for L. P. Gas, Steam, Oxygen, Acetylene, etc.

To connect a Hansen Two-Way Shut-Off Coupling, you merely pull back the sleeve and push the Plug into the Socket. To disconnect, just pull back the sleeve. No tools required. When Coupling is disconnected, similar valves in Socket and Plug shut off both ends of line—practically eliminate spilling of liquid or escape of gas at instant of disconnection.

Hansen Series HK Two-Way Shut-Off Couplings are available with female pipe thread connections from ⅛" to 1" inclusive. Available in brass or steel.

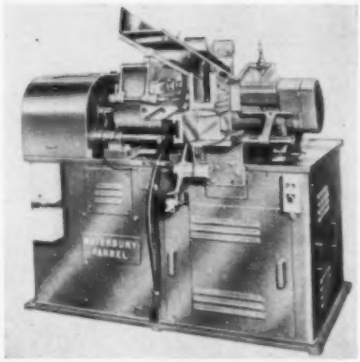
SINCE 1915

REPRESENTATIVES IN PRINCIPAL CITIES

QUICK-CONNECTIVE FLUID LINE COUPLINGS

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 35, OHIO



Thread Roller

Item 420

Machine features semiautomatic feed to produce screw cap threads in shells from 7/16-inch in diameter by ⅝-inch in length up to 4½ inches in diameter by 4 inches in length. Longer tubes can be hand fed and threaded with the feed arrangement removed. A sliding key clutch permits the machine to run continuously on semiautomatic feed, or on one-cycle, hand-feed operation. A swinging tailstock is also provided, which can be adjusted to compensate for axial deflection of the spindle when the work is of heavy gage or of small diameter. **Waterbury Farrel Foundry & Machine Co.**, Waterbury, Conn.

Circle 420 on Page 161

Paper Tape Reader

Item 421

Automatic device can photoelectrically read paper tape information into control and computer systems requiring programmed data. Machine operates at 1000 characters per second, can stop on a single stop-character command in little more than a thousandth of a second. It will then read the next

Circle 694 on Page 161

character within five milliseconds of re-initiation of the read operation.

Photoreader can be adapted to any tape, from five-level to eight-level code. The tape is fed into the unit from plastic reels which can also be used for storage. Up to ten photoreaders can be used on-line with any control or computing system. In the event of power failure or tape breakage, an automatic reel braking and servo shutoff system operates. **ElectroData Div., Burroughs Corp.**, 460 Sierra Madre Villa, Pasadena, Calif.

Circle 421 on Page 161

Automatic Wire Feeder

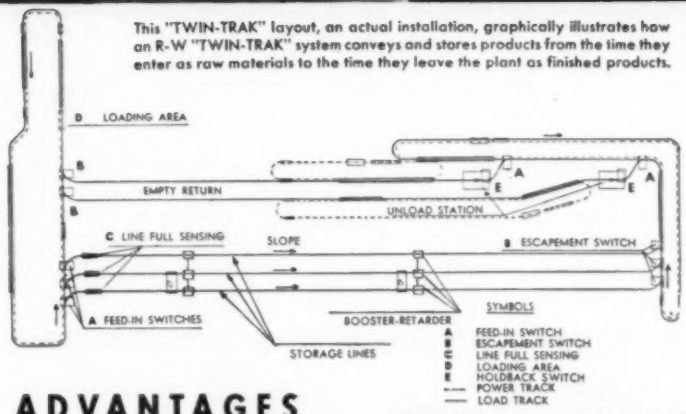
Item 422

Device is designed for use with company's automatic wire cutter and stripper; function is to dereel 1/32-inch to 3/16-inch OD wire from reels up to 12 inches wide and 18 inches in diameter at infinitely variable speeds from 6 fpm to more than 300 fpm. Model 300 is also suitable for use with coil winders and other wire processing equipment.

The operator threads the wire between two feed rolls and through an aluminum dancer tube; then sets the feed to run at a slightly lower speed than the wire stripper, creating a slowly diminishing loop. As the stripper demands wire, the loop slowly decreases until the wire raises the tube. When the wire straightens, lifting the dancer tube, the motor speeds up to create a new loop. Tension never exceeds $\frac{1}{2}$ oz. The feed rolls are coated with an abrasive which grips insulation without damaging it. **Eubanks Engineering Co.**, 260 N. Allen Ave., Pasadena, Calif.

Circle 422 on Page 161

This "TWIN-TRAK" layout, an actual installation, graphically illustrates how an R-W "TWIN-TRAK" system conveys and stores products from the time they enter as raw materials to the time they leave the plant as finished products.

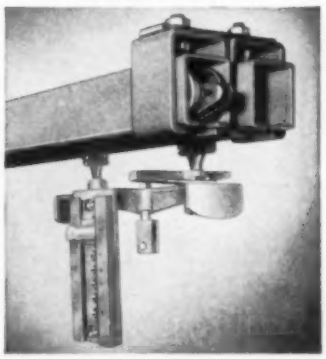


ADVANTAGES

- **Provides trouble-free, automotive-selective control over product movement through entire plant.**
- **Economical and practical . . . provides added storage space . . . saves time, labor and money.**
- **Automatically supplies component parts to work stations from storage banks or lines.**
- **Economical to install . . . extremely flexible . . . quickly and economically revised or modified to meet your changing needs or future expansion plans.**
- **Ideal for conveying and dispatching products in multiple story buildings.**
- **Designed, manufactured and backed by the leading firm in this field for over 75 years.**

WRITE TODAY

for complete information . . . request Catalog F-192.



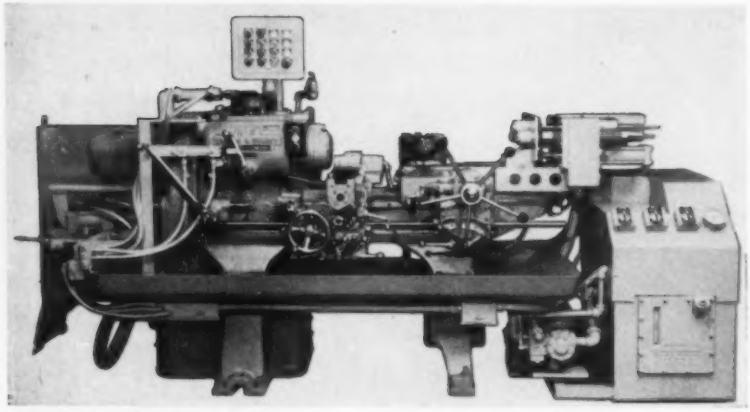
An R-W "TWIN-TRAK" System consists of one or more power tracks and as many storage or free tracks as desired. Available with efficient, economical manual or electronic selective controls designed to effectively meet your specific requirements.

Leading manufacturer of Track Hangers, all types of hardware and Electric Door Operators for over 75 years.

Richards-Wilcox
MANUFACTURING COMPANY
Materials Handling Division

417 W. THIRD STREET, AURORA, ILLINOIS • Branches in Principal Cities

Circle 695 on Page 161



Lathe Control Unit

Item 423

Director automatically controls turret lathe functions such as forward or reverse spindle rotation, open or close collet, low or high clutch, turret and cross slide jog forward or reverse, at feed or rapid traverse, and cycle start and stop. Feed rate ranges from zero to a maximum of 100 inches per minute—different feed rates can be established for front or back tool.

The headstock spindle speeds, ram, cross slide functions, and the operations are preselected by a six position drum and a multiswitch assembly, or sequence selector. The six positions of the drum correspond to the six hex turret positions and each position energizes certain switches, establishing the functions to be performed at each hex turret station. These operations do not require any cams. The hex turret feed selector, which is a longitudinal drum, has three adjustable actuators for each hex face. The drum controls from forward rapid traverse to feed, from feed to forward rapid traverse, permits skip feeding, can also be used to control back feed when required.

The cross slide feed selector which consists of a longitudinal plate, has three adjustable actuators. The first controls the point at which the front tool goes from rapid traverse into feed. The second controls the point at which rear tool goes from rapid traverse into feed and the third determines the point at which the cross slide is in center position, allowing clearance for hex turret. A safety feature is an overload device which reverses the tool when the tool slides hit a dead stop and protects against overload if the tool is dull or broken. **De Silvey Corp.**, 200 Pennsylvania Ave., East Aurora, N. Y.

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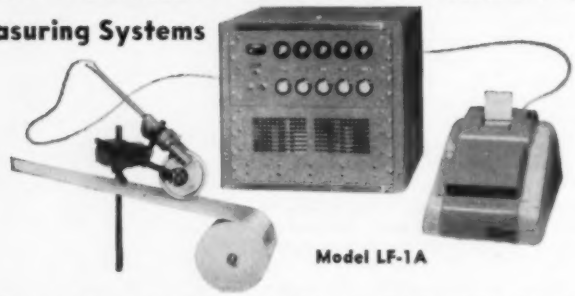
POST DECITRON ELECTRONIC PRODUCTS

Measuring Systems



Model LF-1A

Now! . . . a permanent record of lineal footage. The Post LF-1A Lineal Footage System combines the accuracy of proven electronic equipment with a visual "Clary" readout.

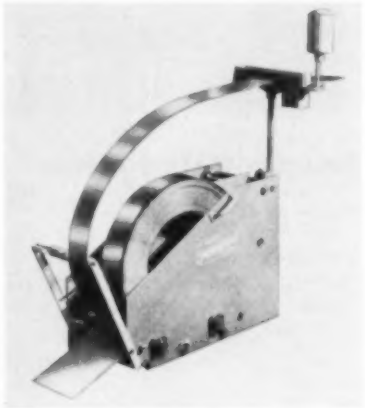
Ideal for accurate measurement for manufacturers of wire, paper, textiles and sheet metals. Sensing elements can be furnished so that measurements can be made in 1/16ths of an inch, 1/8ths, 1/4's or in full inch increments.

Write for literature.

Decitron

POST ELECTRONICS

Division of Post Machinery Co. | 161 Elliott St., Beverly, Mass.



Coil Feeder/Oiler

Item 424

Equipment is capable of handling stock to 24 inches wide by 48 inches in diameter, and up to 3000 lb weight. The metal coil is rolled up the ramp onto the power driven rollers. An oiler included on the machine cleans and oils the stock as it is fed. The combination cradle and oiler can be moved from one press to another wherever automatic stock feeding, cleaning, and oiling are necessary. The slack loop is stored above the unit, thereby saving floor space. **Medelton Co. Inc.**, 335 E. 142nd St., Bronx 54, N. Y.

Circle 424 on Page 161

Circle 696 on Page 161

Industrial Filter

Item 425

Device can be hooked into any coolant or hydraulic fluid line, is suitable for use on industrial liquids such as oil, acids, or water. Unit combines two filtration methods; Diatomaceous powder and fine-mesh wire cloth. The filter traps suspended solids and foreign particles down to a size of 1/10 micron. The powder can be fed to the filter at any time without opening the unit or interrupting operation. A pressure gage at the top indicates when cleaning is required. This operation takes less than five minutes. Unit is available with a glass or rubber lined tank. **Bellwood Engineering Inc.**, Bellwood, Ill.

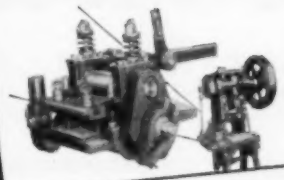
Circle 425 on Page 161

Circular Workstand

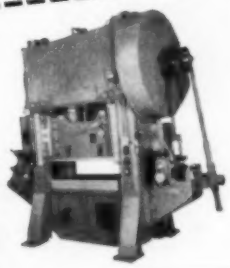
Item 426

Applicable for single or multiple drilling, tapping, facing, and chamfering setups, table assembly provides mounting space for up to six tooling components. Unit consits of a circular table, a clamp, and a base to which a foot pedal can

LITTELL ROLL FEEDS



LITTELL STYLE M FEEDS
6 sizes for single automatic feeding to standard presses. Feed stock up to .055" x 8", left to right or right to left. Feed length ranges, 0-2" through 0-4⅜" with plain gears and 0-4½" through 0-8½" with compound gears. Built for years of high speed, low cost automation feeding.



LITTELL STANDARD RACK AND PINION FEEDS
No. 6-12½ Littell Double Rack and Pinion Roll Feed mounted on brackets on right and left side of Straight Sided Press. Equipped with eccentric roll lifters. Littell Feeds to fit OBI presses are also available. Accessories such as oilers, straighteners and scrap cutters supplied at additional cost. Get catalog information.

AUTOMATE

YOUR PRESENT PRESSES FOR UP TO 5 TIMES MORE OUTPUT

Want more output from your present presses? Equipped with Littell Roll Feeds those presses will punch out two to five times more stampings per hour. These Littell Feeds are pre-engineered to fit standard OBI or Straight Sided Presses and they come ready to install. Delivery is fast, installation simple. Your investment comes back in a hurry through the increased output, lower stamping costs, operator safety and lower insurance rates.

GOOD DELIVERY

Enlarged plant, new equipment to speed delivery.

SEE OUR CATALOG IN SWEET'S

USE COUPON
to get full facts on Littell Feeds.

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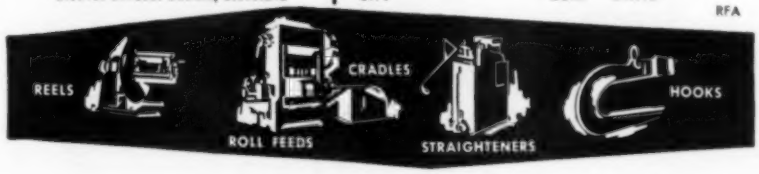
4105 N. Ravenswood Ave.
Chicago 13, Illinois
District Offices: Detroit, Cleveland

F. J. Littell Machine Co., 4105 Ravenswood, Chicago 13, Ill.
Send Catalog Sections "A" Describing Littell Roll Feeds.

NAME _____
COMPANY _____
STREET _____
CITY ZONE STATE

RFA



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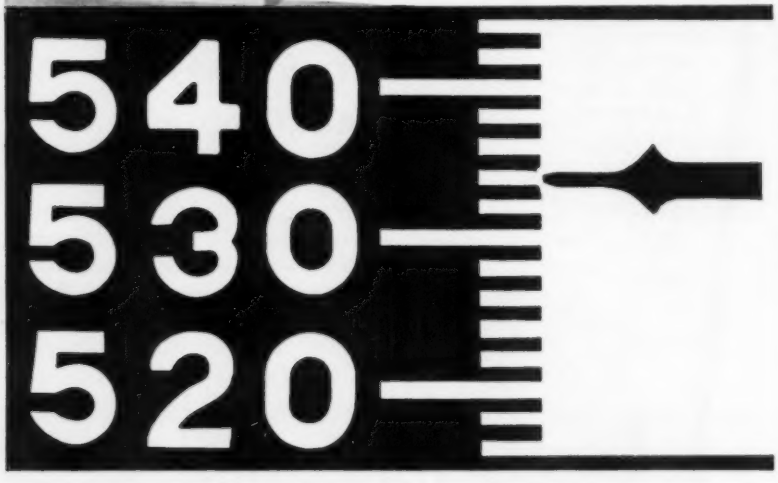
HOWE

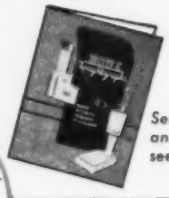
WEIGHTOGRAPH

READ WEIGHT IN NUMBERS THIS BIG

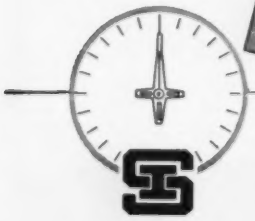


NO MORE "SCALE SQUINT!"

Pin up this ad and look at it from across the room—see how easy it is to read the weight! You can attach a Howe Weightograph to any beam scale, from small bench scales to the largest truck and railroad scales; different models available for different capacities. Standard models plug into ordinary electric outlet. So much easier, faster, more accurate, it quickly pays for itself. Use indoors or out . . . adjusts to eye level . . . parallax errors are completely eliminated.



Send for this detailed booklet and local representative's name—see the Weightograph demonstrated!



HOWE

THE HOWE SCALE COMPANY • RUTLAND, VERMONT

A SUBSIDIARY OF SAFETY INDUSTRIES, INC.

ELECTRICAL DIVISION • ENTOLETER DIVISION
LIGHTING DIVISION • AUTOMATIC TIMING & CONTROLS

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be added. In illustration shown, table is set up with company machining units. Units are nose-mounted, with simple brackets, in position for automatic drilling, tapping, and facing work. **Dumore Co.**, 1300 Seventeenth St., Racine, Wis.

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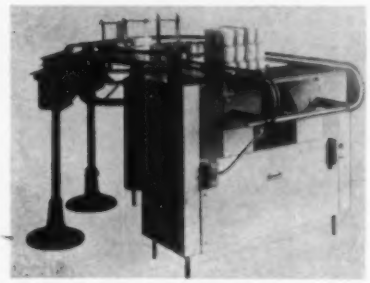
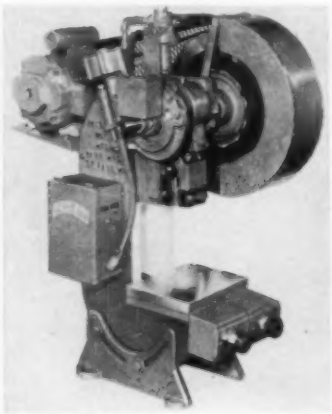


Container Unloader

Item 427

Device is capable of handling glass containers and cans packed in 2, 3, or 4 tiers. Machine is adjustable to the size of container to be handled. The table of this unloader moves automatically to the correct level to feed each successive tier of containers to an unscrambler. The chance of containers tipping over is minimized because the dumping table is always level. **Island Equipment Corp.**, P. O. Box 380276, Miami 38, Fla.

Circle 427 on Page 161



5 Ton Press

Item 428

Machine features an air operated friction clutch which allows increase in speed over models not so equipped from 225 to 450 spm. The clutch

and brake are the constricting drum type, interlocked to prevent either from being engaged while the other is operating. If air or electric power fails, the clutch disengages and the brake, which is air-released, stops the press. A switch sets the press for single stroke or continuous operation. **Press-Rite Div., Sales Service Machine Tool Co.**, 2365 University Ave., St. Paul 14, Minn.

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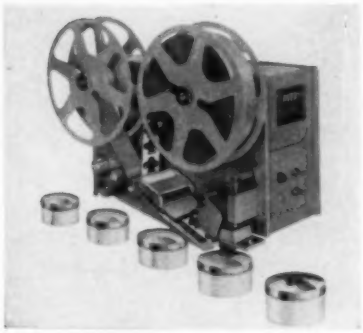


Automatic Labeler

Item 429

Unit is designed to apply pressure-sensitive labels to items such as electrical components, tools, pharmaceuticals, hardware, and housewares. In operation, the labels, die-cut and printed to specification, are furnished in rolls in quantities up to 20,000 per roll. The labels are fed to an impressor which in turn applies them individually to a specific position on the product or package to be labeled. At the moment when the impressor removes the label from the peeling edge, a dispensing switch provides another label and the backing tape is carried away by an automatic rewind unit. Speeds of 20 to 300 labels per minute can be obtained, depending on the product.

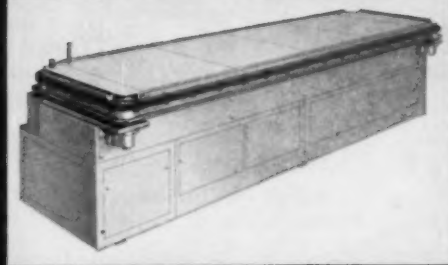
Model 100 can be mounted vertically, on its side, over a conveyor, or on legs that adapt it for bench labeling operations. It can be positioned to provide clearance for various types of fillers, weighers, wrappers, and sealers. Unit is designed to handle labels ranging in size from 1/4-inch to 2 1/4-inch wide by 6 inches long. Modifications can be made for other sizes. Labeler is operated by a 110 v, 60 cycle, 1-phase motor. **Avery Adhesive Label Corp.**, Monrovia, Calif.

Circle 429 on Page 161

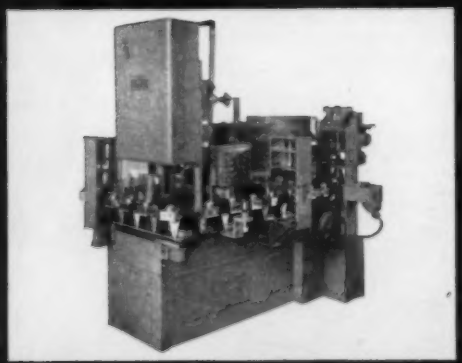
Circle 699 on Page 161→

STARTING POINT FOR AUTOMATION

BENERSON AUTOMATOR



Pre-engineered, the automator provides an advanced starting point for your automation problems. Benerson automation minded engineers recommend the right size automator for your job requirements—then design and build the necessary devices for feeding, including orienting, placing and ejecting assemblies. Any field of industry involved in volume parts assembly is ready for automation... and the automator is the starting point.



The machine pictured above utilizes a 6 foot automator to hold 29 stations at 7 ½" indexes. The Benerson Automator delivers complete assemblies in seconds. A range of stations and indexes can be utilized to fit your assembly problems.

FURTHER INFORMATION AND DETAILS ON REQUEST. WRITE:

BENERSON CORPORATION

STATION A, BOX 127, EVANSVILLE, INDIANA

Benerson Engineers Are Automation Minded

Is direct labor a high percentage of production cost?
Would an increased production rate lower cost?
Is machine "idle time" for part loading and unloading high?
Does operator fatigue influence product quality?

IF YOU ANSWER "YES" TO ONE OF THESE FOUR QUESTIONS BELLOWS SPOT-A-MATION WILL PAY OFF QUICKLY

● What is SPOT-A-MATION? It's applying automation principles to separate manufacturing operations by the use of Bellows "Controlled-Air-Power" Work Units.

These pneumatic powered devices can be quickly installed on standard machines to make them fully automatic; they can be used to combine or couple an operation with a preceding or following one; they can form the key units in low cost, toolroom-built, special purpose machines . . . they can be used to automate a single machine, or an entire department . . . and, nine times out of ten, will pay for themselves in the first few weeks of operation.

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SPOT-A-MATION PORTFOLIO

Schematic layouts, wiring diagrams, photos showing simple ways to automate standard machines. Free on request. Write Dept. AU-958, The Bellows Co., Akron 9, Ohio. In Canada: Bellows Pneumatic Devices of Canada, Ltd., Toronto 18.

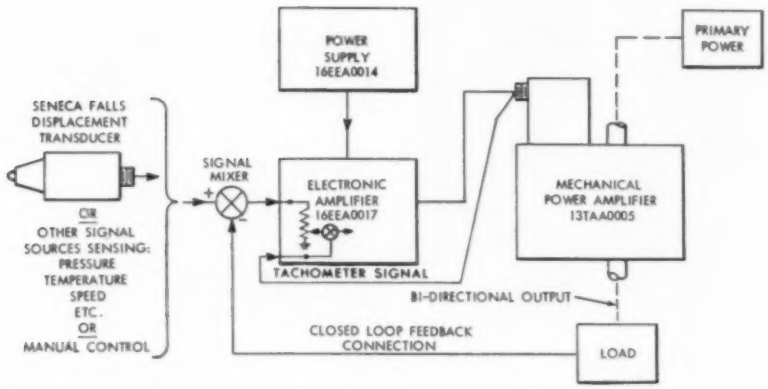
The Bellows Co.
DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION
AKRON 9, OHIO

1195-B

AUTOMATION new components

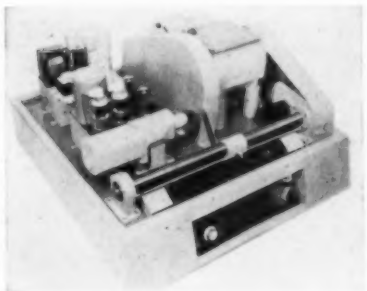
Parts, elements and devices designed for creating more automatic systems

For detailed information and literature, use card page 161.



Electromechanical Control System

WIDE range of applications for control system includes use on tracer lathes, variable and precise speed controls, vibration exciters, process and proportioning controls, and material handling equipment. The system, designed by **Electronics Div., Seneca Falls Machine Co.**, 12 Fyfe Bldg., Seneca Falls, N. Y., contains a signal comparator, a power supply converter, an electronic amplifier, and a mechanical power amplifier. The system is composed of "building block" type components to provide a variety of control arrangements. It can be used in conjunction with computers, or with signal sources sensing linear motion or distance, pressure, temperature, flow, and speed. Units are used to control a servomotor in the mechanical power amplifier. They can also be used to control relays or solenoids from low level sources. By using the appropriate transformer tap and matching the load to the amplifier, the maximum power available will be transferred to the load. For systems requiring no tachometer signal, the amplifier can accept two ac signals and provide output power proportional to either the sum of or the difference of these signals.



Function of the power supply is to convert an ac input voltage to the filament and dc voltage needed to operate the electronic amplifier. It also provides an excitation voltage for a transducer, when it is used as a signal source to obtain low level control signals. Pilot lights on the supply indicate the existence of ac input voltage and dc output voltage. Separate fuses protect the ac supply line from filament and dc voltage circuit overloads. The electronic amplifier will accept low level ac signals from a speed sensing tachometer on the mechanical power amplifier and add them electronically to provide output power proportional to their sum. The electronic amplifier has a gain control for the ac control signal; its output power is available at various impedance levels through a combined isolation and matching transformer.

One of the advantages of using a mechanical power amplifier in the system is that the output power from the electronic amplifier energizes the control phase of the two-phase servomotor in the mechanical power amplifier, where the servomotor output is mechanically amplified to provide a higher power output. High speed response is obtained with a 60 cps servomotor-tachometer which provides system response for inputs up to 8 cps; for requirements above this frequency the substitution of a 400 cps servomotor will provide closed loop systems which respond to frequencies up to 25 cps. The system is available for applications requiring $\frac{1}{4}$ to 100 hp.

Circle 430 on Page 161

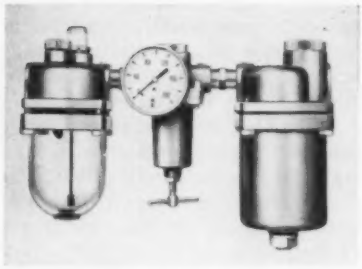
Cylinder Cushion Valve

Item 431

Device precisely regulates air flow and piston speed at any point in the stroke, permitting air cylinders to operate at maximum speed while providing controlled acceleration or deceleration as required. The position of the tapered valve stem determines rate of air flow or discharge from the cylinder. A free return check valve permits air return to cylinder at full pipe ca-

pacity. The poppet position is established by a machine cam which actuates the valve roller lever. Position and length of cam determines rapidity of piston deceleration or acceleration. Valve is available in six pipe sizes from ¼ inch to 1¼ inches. **Numatics Inc.**, Highland, Mich.

Circle 431 on Page 161



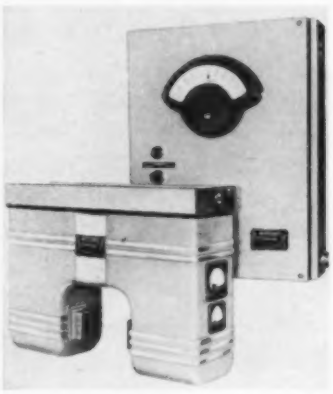
Air Line Control

Item 432

Devices are suitable for use on all air-operated equipment such as air tools, cylinders, motors, clutches, and chucks. Unit includes an air line lubricator, water separator, and air pressure regulator. The lubricator is the concentric venturi design. The oil venturi admits the oil directly to the center of the air venturi, in correct, measured quantity. A single control meters the exact amount of oil brought up to the oil venturi by controlling the pressure differential in a bypass air circuit.

Lubricator is capable of handling all air line pressures up to 200 psi, and all viscosities up to 500 SSU at 100 F. An oil sight dome permits visual observation. The nine-ounce capacity reservoir which can withstand temperatures up to 120 F, can be filled while the unit is in operation. The baffle-type water separator automatically removes and dumps all the condensate present in the air line under normal operations. A strainer extracts rust and scale particles from the air stream. Pressure regulator provides adequate control of air operated equipment, prevents damage or erratic operation due to excessive pressures or sudden surges. Designed for inlet pressure up to 250 psi, the regulator can be adjusted to any pressure up to 125 psi. **Alemite Div., Stewart-Warner Corp.**, 1826 Diversey Pkwy., Chicago 14, Ill.

Circle 432 on Page 161



Diameter Gage

Item 433

Instrument continuously measures the diameter of insulated cable after insulation is applied, and controls production equipment to hold the diameter within close tolerances. In operation, the instrument signals control equipment when diameter deviations exceed preset limits, and this equipment activates the extruder to apply more or less insulating material.

The gage functions by detecting variations in the shadow size of insulated cable. The cable passes through the gage head, between a light source on one side and a phototube detector on the other. The detector generates electronic signals, the signals depending on the light which reaches the detector. The amount of light depends on the diameter of the cable. These signals are amplified, translated, and displayed in thousandths of an inch on a wide-scale meter. They are recorded on a strip chart recorder, thus providing a continuous record of diameter deviations of all cable produced. **Rod & Wire Div., Industrial Gauges Corp.**, West Englewood, N. J.

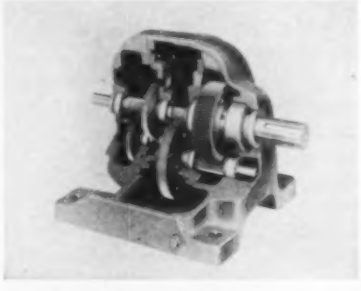
Circle 433 on Page 161

Air-Powered Drill

Item 434

Unit is available in three basic speeds from 700 rpm to 14,000 rpm. It has a provision for regulation over a wide range to suit conditions of drill size and material hardness. A muffling system reduces motor noise and quiets the exhaust air which is directed out through the attachment. Model 11A-1, a straight drill, is shown; Model 11G-1 an angle drill for close-quarter applications can be furnished with a variety of drill chucks or collet attachments. Other air tools in the line are screw drivers and nut setters. The same basic motor used in the drill is used on the other units. **Gardner-Denver Co.**, Quincy, Ill.

Circle 434 on Page 161

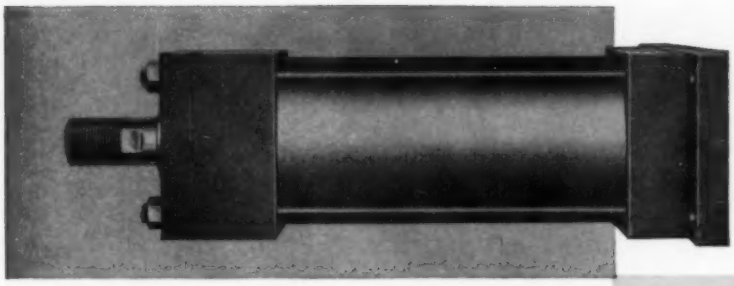


Helical Gear Drive

Item 435

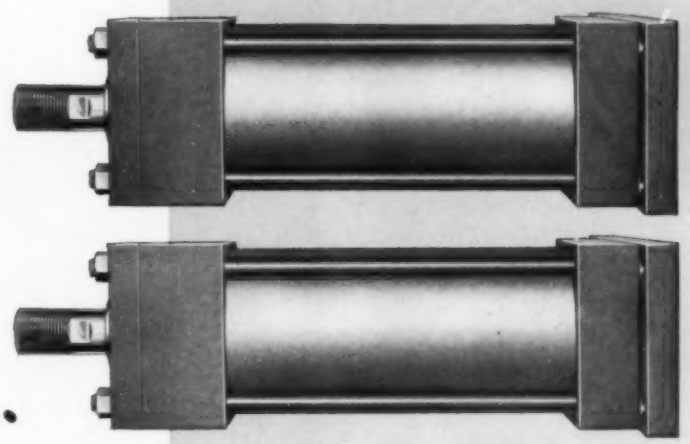
Quadruple reduction speed reducer (cutaway view shown) is available in five sizes, has a range of ratios up to 2,217:1, with capacities to more than 200 hp. The gear arrangement features helical gear trains operating in high capacity ball and roller bearings mounted in a cast iron housing. Unit provides automatic splash lubrication of all moving parts. **Link-Belt Co.**, Dept. PR, Prudential Plaza, Chicago 1, Ill.

Circle 435 on Page 161



SHOWN HERE:
A Logansquare cylinder and
2 competitors' cylinders

do they LOOK ALIKE? ...sure they do on the surface...



...BUT LOOK AT Logan's BIG EXTRA PLUS VALUES

Logansquare Cylinders

are made to interchange with other leading manufacturers' cylinders . . .

1. Logan designs assure the service required for those extra-rugged applications.
2. Over FORTY YEARS of cylinder manufacturing know-how.
3. Built by CRAFTSMEN whose average service record with LOGAN is more than 20 years.
4. Manufactured in a plant which applies the most modern production methods.

FREE

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MEMBER: Natl. Mach. Tool Builders' Assn.; Natl. Fluid Power Assn.

LOGANSPORT MACHINE CO., INC.
848 CENTER AVENUE, LOGANSPORT, INDIANA

PLEASE SEND COPY OF CATALOG:

- ☐ 100-1 AIR CYLINDERS
- ☐ 100-2 MILL-TYPE AIR CYLS.
- ☐ 100-3 AIR-DRAULIC CYLS.
- ☐ 100-4 AIR VALVES
- ☐ 100-5 LOGANSQUARE CYLINDERS
- ☐ 100-6 ULTRAMATION CYLINDERS
- ☐ 300-2 PRESSES
- ☐ FACTS OF LIFE
- ☐ 200-1 HYD. POWER UNITS
- ☐ 200-2 ROTOCAST HYD. CYLINDERS
- ☐ 200-3 750 SERIES HYD. CYLINDERS
- ☐ 200-4 AND 200-7 HYD. VALVES
- ☐ 200-6 SUPER-MATIC CYLS.
- ☐ 300-1 CHUCKS
- ☐ ABC BOOKLET
- ☐ CIRCUIT RIDER

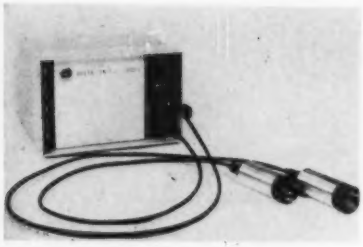
TO:

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

Circle 701 on Page 161



Measurer/Controller

Item 436

Instrument measures any physical quantity (such as pressure, temperature, and vibration) which can be converted into a change in capacitance and into a phase sensitive differential dc voltage. Input from a small capacitance sensor can become an output voltage large enough for indicating, recording, and controlling.

Model 902-1 accepts initial capacitance from 1 to 50 mmf and provides maximum signals of ±30 v dc. Unit contains a single measuring probe and cable assembly, and an additional one can be furnished so that two measuring probes can be operated simultaneously. **Decker Corp.**, Bala Cynwyd, Pa.

Circle 436 on Page 161

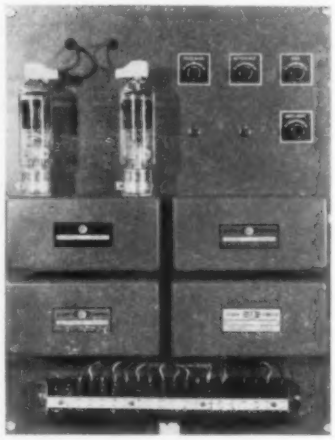
Motor-Driven Timers

Item 437

Synchronous motor-driven devices are available with one, three, and five minute timing units. The one minute unit is adjustable in one second increments, zero to 60 seconds; the three minute unit is adjustable in three second increments, zero to 180 seconds; and the five minute unit is adjustable in five second increments, zero to 300 seconds. All timing units are interchangeable with one another.

To set the timer, a pointer is depressed and rotated to the desired position on the external indicating dial. A feature of the unit is the automatic reset mechanism which returns a sweep-second pointer to the *Start* position after each completed cycle. In the event of power failure, the pointer automatically returns to the *Start* position. Motor operates on 110 v, 60 cycles. For 220, 440, or 550 v, 60 cycle service, a control transformer and terminal block are added. **Cutler-Hammer Inc.**, 378 N. 12th St., Milwaukee 1, Wis.

Circle 437 on Page 161



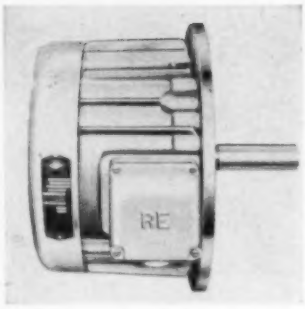
Two-Stage Regulator

Item 438

Unit is applicable on adjustable-voltage dc drives or any operation requiring voltage and current regulation in speed, tension, and position controls. Model GS has a magnetic amplifier control input stage and a grid-controlled rectifier power output stage. Unit includes an exciter unit for power, grid switching unit to control the output rectifier, reference unit, and time delay unit.

The magnetic-amplifier control stage provides multiple electrically-isolated inputs at low power and impedence levels. The power output stage uses a single pair of gas-filled rectifier tubes to provide high power output with fast response and inversion ability. Regulator is available in three sizes; 5 amp maximum, 12.8 amp maximum, and 36 amp maximum, with intermediate ratings available. It is rated for 220, 440, or 550 v ac, single phase, 60 cycles. **Clark Controller Co.**, 1146 E. 152nd St., Cleveland 10, Ohio.

Circle 438 on Page 161



Machine Tool Motor

Item 439

Unit features a fin type design which provides efficient heat dissipation ratio. Motor also features vibrationless running characteristics. The rotor is dynamically balanced and mounted between two heavy-duty ball bearings. Radial air gap design permits the use of light, thin, low, inertia rotor which results in smooth starts and quick stops. Motor is furnished in the totally enclosed fan cooled type or totally enclosed nonventilated type, for continuous or intermittent duty; is available in ratings from ½ through 10 hp. **Reuland Electric Co.**, Alhambra, Calif.

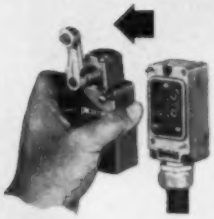
Circle 439 on Page 161

Metal Bowl Filter

Item 440

Replaceable metal bowl filter is designed for ¾ and 1-inch air lines where temperatures reach 200 F and 300 F. Unit can be furnished with manual or automatic drain. Metal bowl models embody the directional louver which creates a strong centrifugal action and removes corrosive liquids from the air stream. All units are available with a choice of three interchangeable filter elements—a 74-micron, 200-mesh, reinforced Monel wire screen, and 64-micron and 25-micron sin-

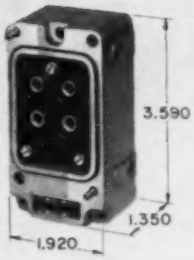
MICRO SWITCH Precision Switches



PULL OUT

PLUG IN

18 PA1 Terminal Enclosure—is common to all actuator assemblies in the "200LS" series. Can be mounted from front, back or either side.



Actuator plugs into terminal enclosure—contains all moving mechanical and electrical parts.

NEW...

"Plug-in Limit" Switch cuts costly downtime

Compact sealed enclosures with choice of 6 actuators meet wide range of industry needs

Here's a precision limit switch you can replace complete in 20 seconds! Downtime is all but eliminated!

The switch enclosure of this new "Plug-in Limit" switch, in any of six actuator styles, plugs into the terminal enclosure like a radio tube . . . is precisely positioned by dowel pins and secured by two No. 10 screws. Together, the two parts form a complete unit, sealed against oil, water, dirt and dust.

The "Plug-in Limit" is two-circuit double throw. Electrical rating is 10 amps. 120, 240, 480 vac; ½ H.P. 120 vac; 1 H.P. 240 vac; 0.8 amp. 115 vdc; 0.4 amp. 230 vdc; 0.1 amp. 550 vdc. Pilot duty rating is 600 vac max. Meets NEMA Industrial Control Standards.

Authorized distributors everywhere maintain stocks. MICRO SWITCH technical specialists are available at the sales office near you. For details of the new "200LS" Series, send for Catalog 83.

—•—

MICRO SWITCH...FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls, Ltd., Toronto 17, Ont.

—•—

The two-word name MICRO SWITCH *is* NOT *a generic term. It is the name of a division of Honeywell.*

201LS3 Adjustable Arm Rotary Actuator—roller lever arm is adjustable to any point in a 2½-inch range. Head assembly can be positioned to any of 4 sides of switch. Actuating direction and operating point are adjustable.

208LS1 Coil Spring Actuator—flexible spring actuator for multi-direction operating motion

201LS10 Rod Actuator—provides light actuating force. See adjustability details under 201LS1 below

205LS1 Roller Plunger Actuator—adjustable at 90° angles

202LS1 Push Plunger Actuator—for in-line actuating motion

201LS1 Roller Arm Actuator—field adjustable for actuation clockwise, counter-clockwise, or in both directions. Arm is adjustable through 360°. Head can be faced in any of four directions.

Look for the name of MICRO SWITCH *Authorized Distributors in the Yellow Pages*

Honeywell
MICRO SWITCH PRECISION SWITCHES

Circle 690 on Page 161

This long horizontal Slat Conveyor aids mass production of power transformers. Winding machines flank both sides and coils are lifted onto conveyor by overhead crane. Movement is toward drying oven in rear where coils are upended automatically before entering oven.
SALES begin in the SHOP

GROWING competition for sales has produced among other benefits, an all-out effort to curb waste. Waste, whether measured in materials, labor, time or space, is a luxury that today's business can ill afford. Losses in these areas often can be reduced or even eliminated by more efficient materials handling—with a favorable effect on price and sales volume.

Logan Conveyors have been employed by successful companies for nearly a half century in solving materials handling problems. Logan's expert engineering staff is ready to help you, too.

For more information or an engineer's call write to—

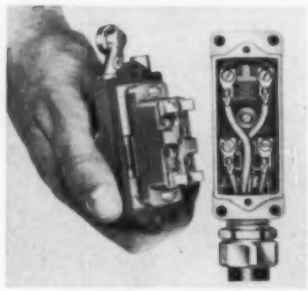
LOGAN CO., 218 CABEL ST., LOUISVILLE 6, KY.

Logan Conveyors

Circle 703 on Page 161

tered metal elements. **C. A. Norgren Co.**, 3400 S. Elati St., Englewood, Colo.

Circle 440 on Page 161

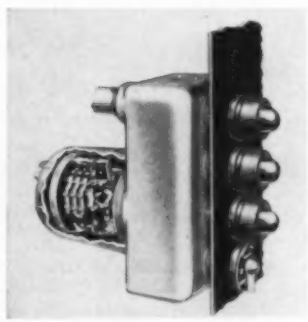


Plug-In Limit Switch

Item 441

Device features reversible switch mechanism, can be plugged in with the roller arm at either the top or bottom. Combined with the receptacle; which can be mounted on its base or on either side, with the conduit opening at top or bottom; the unit has six different mounting arrangements. Switch requires 5 degrees to operate, allows 25 degrees overtravel. Switch action can be reversed by a screwdriver adjustment. **Square D Co.**, 4041 N. Richards St., Milwaukee 12, Wis.

Circle 441 on Page 161



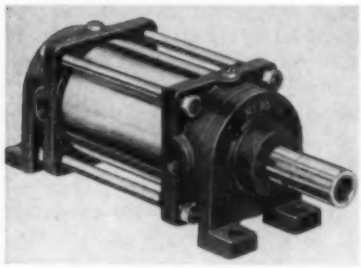
Visual Alarm

Item 442

Capable of indicating normal and abnormal temperatures, pressures, liquid levels, speeds, and loads, alarm features a high-speed flasher. In addition to the visual signal, an audible one can be incorporated into an independent circuit to actuate a horn, siren, or bell. A reset switch silences the horn or bell and changes the alarm light from flashing to steady until the fault is corrected.

Unit is available in two styles. Model EKP is explosion-proof, is designed for use in chemical process industries, oil refineries, or other hazardous locations. Model KP is dust-ignition-proof and weather-resistant, is suitable for use in grain handling and food processing plants. **Crouse-Hinds Co.**, Syracuse 1, N. Y.

Circle 442 on Page 161

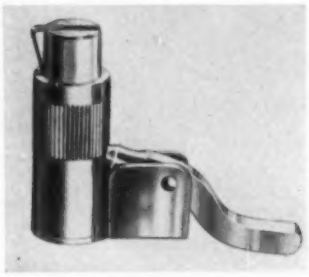


Double-Acting Cylinder

Item 443

Line of double-acting cylinders is available with bore sizes from 1½ inch to 4 inches. Styles are horizontal (shown), vertical, pivot, or face mounted. Unit has internal cushioning at both ends; by removing the cushion adjustment screws it converts to a noncushioned cylinder. The ram bearing is in a quick-detachable cartridge; the ram bearing surface is in 3 to 1 proportion to the ram diameter. Cylinder is designed for working pressure of 250 psi. **Mead Specialties Co.**, AC-46, 4114 N. Knox Ave., Chicago 41, Ill.

Circle 443 on Page 161

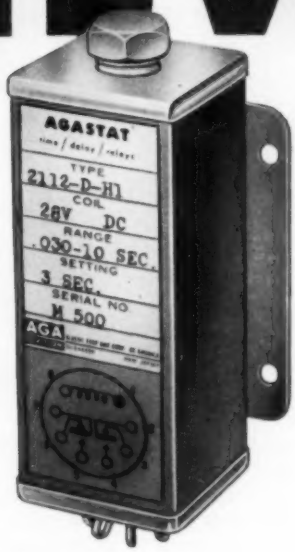


Automatic Die Stop

Item 444

Mechanism is capable of stopping material prior to the piercing, shearing, or blanking operation. It is actuated by an adjusting screw located in the top die shoe. Installation is accomplished by drilling and ream-

NEW



MINIATURE AGASTAT®

time delay relay

for . . . missile, aircraft and electronic applications

INSTANTANEOUS RECYCLING . . . reset time—less than .020 seconds

UNAFFECTED BY VOLTAGE VARIATIONS . . . time delay remains constant from 18 to 30 volts DC

ADJUSTABLE . . . time delays from .030 to 120 seconds

CHOICE OF OPERATION . . . for either energizing or de-energizing

SMALL . . . height—4⅜" . . . width—1-13/16" . . . depth—1½"

LIGHT . . . maximum weight—15 ounces

MEETS ENVIRONMENTAL REQUIREMENTS OF MIL-E-5272A

This new AGASTAT time delay relay is an externally adjustable, double-pole, double-throw unit. It incorporates the basic AGASTAT timing principle, proved by a half-century of reliable operation on automatic aids to navigation, in a space-saving miniature unit, built to withstand the rugged environmental conditions of missile and aircraft applications.

For specific information on the new AGASTAT relay for your application, write to Dept. A29-923.

AGA DIVISION **ELASTIC STOP NUT CORPORATION OF AMERICA**

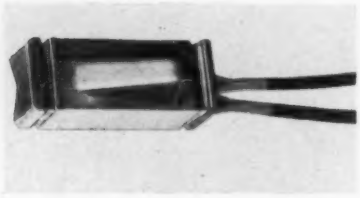
1027 Newark Avenue, Elizabeth, New Jersey

Pioneers in pneumatic timing

Circle 704 on Page 161

ing a hole in the desired location and pressing the stop in position. Unit provides a rigid gaging surface, does not depend on a loose fit to function properly. **Keystone Engineering & Mfg. Co.**, 122 S. W. 16th St., Des Moines, Iowa.

Circle 444 on Page 161

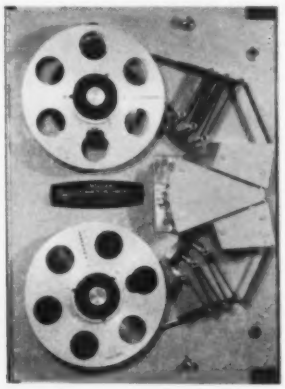


Lever Actuated Switch

Item 445

Designed for short cycle operations, switch is suitable for either normally open or normally closed contacts. Lever actuator has finger tip control for recycling. The lever is totally enclosed in a silicone boot for protection against environmental conditions. The back of the switch contains a lengthwise V-groove for mounting on rods or small angular sections. Unit has a life expectancy of 25,000 cycles, is rated for 155 v ac, 15 amp. **Control Products Inc.**, 306 Sussex St., Harrison, N. J.

Circle 445 on Page 161



Recorder/Reproducer

Item 446

Applicable in data processing operations and industrial fields, instrument provides for a wide range of standard tape speeds and tape widths. Standard speeds range from 7½ to 100 ips. Two low speeds (0.4 and 0.8 ips) and a high speed (150 ips) are available. Tape widths are ¼, ½, ¾, and 1-inch. Start and stop times are less than 3 milliseconds, with an accuracy of 0.05-inch, in forward and reverse directions. Units incorporate end-of-tape sensing, metal surface heads, fast forward and rewind (250 ips). Unit has a minimum operational life of 5,000 hours.

Digital recording inputs can be accepted from such sources as analog-to-digital converters, punched paper tapes, punched cards, and tape readers. The readout of the digital magnetic tapes can be used to feed digital computers, card punches, machine tool program control units, and data printers. **Consolidated Electrodynamics Corp.**, 300 N. Sierra Madre Villa, Pasadena, Calif.

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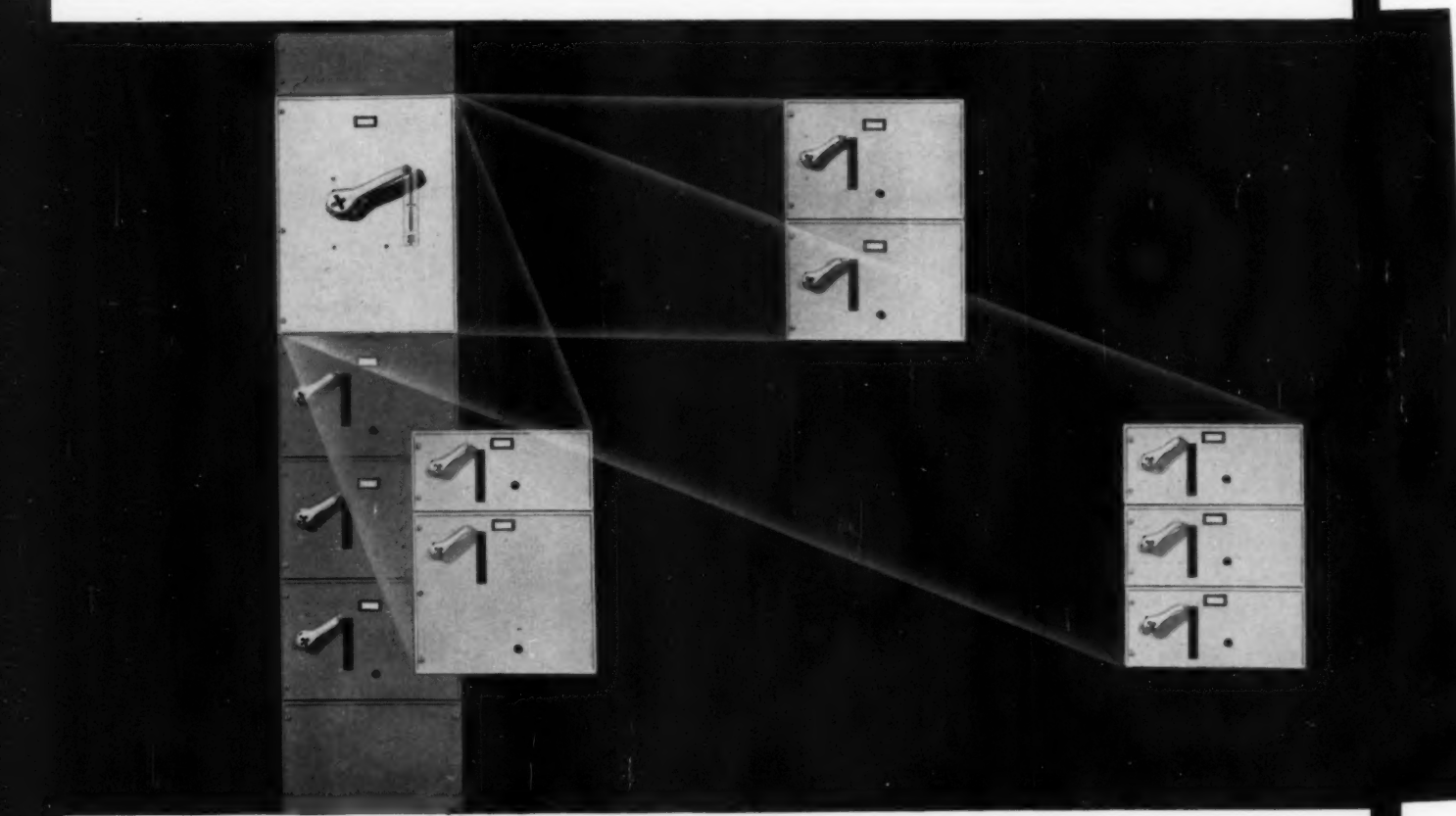
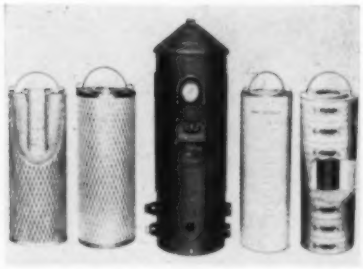
Cartridge Type Filters

Item 447

Designed for hydraulic fluids, fuels, and mineral oils; filter features two types of interchangeable cartridges. Model 5 removes all solid contaminants down to 5 mu in one pass; is made from resin-





impregnated pleated paper, has 6300 squares inches of filtering surface. This cartridge is most suitable for water-base hydraulic fluids, refined fuels such as gasoline, refined diesel fuels, and on any type of mineral oil. Because of its minimum resistance to flow, it is also recommended for oils of high viscosity. Unit will not remove oil additives, and will not disintegrate or be affected by water or water solutions.

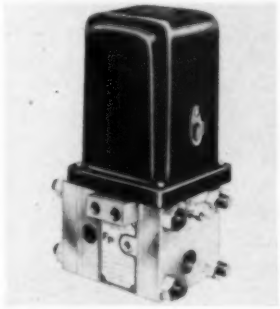
Model K contains 13 lb of fuller's earth enclosed in a metal container, is suitable for the removal of solid and dissolved contaminants such as acids, tars, and asphaltenes. This cartridge is particularly resistant to water. **Indiana Commercial Filters Corp.**, Lebanon, Ind.

Circle 447 on Page 161

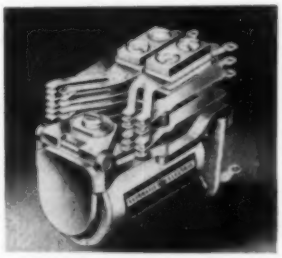
Pressure Transmitter

Item 448

Line of differential pressure transmitters for level measurement and for the measurement of differential pressures of 0-20 inches to 0-200 inches and 0-30 inches to 0-300 inches, is available either with or without adjustable zero suppression. Unit operates up to 1500 psig working pressure, has over-range protection. Calibration stability under changing temperature or pressure conditions is less than 1 per cent of range per 100 F; and less than 1 per cent per 1000 psi static pressure change. Measuring circuit is completely immersed and sealed in silicone oil. The transmitter is furnished with a corrosion-proof fiber glass cover. **Fischer & Porter Co.**, 763 Jacksonville Rd., Hatboro, Pa.



Circle 448 on Page 161



Miniature Relay

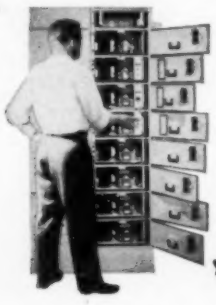
Item 449

Designed for use in portable electrical circuit analyzers and data processing equipment, device is also applicable wherever space is limited. Some of the features of the miniature unit are: The thickness of the armature arms which helps the unit to retain its proper stroke under heavy loading or severe operating conditions; the make and break springs and the mating armature springs are all bifurcated; and the

Westinghouse CONTROL CENTERS feature dual-modular units to solve your space problems

The efficient design of these new Westinghouse units is the answer to today's . . . and tomorrow's . . . need for complete flexibility in control center installations. Westinghouse control centers are ready to meet any demand for expansion or modification.

You get complete versatility with dual-modular units, plus unit space selection to meet your demands. Steel or aluminum Westinghouse control centers will house a complete range of devices to meet specialized control requirements.



For complete information on the control center for your plant, call your local Westinghouse representative. Or, write Westinghouse Electric Corporation, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

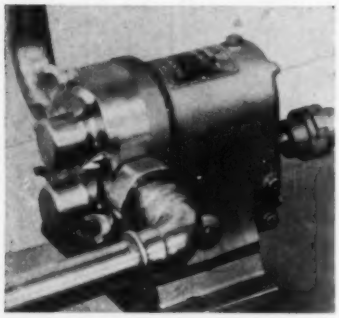
J-22107

POWER-UP starts with CONTROL

YOU CAN BE SURE...IF IT'S Westinghouse

design of the terminal spacing makes all terminal rows accessible for wiring. Service life of the relay is from 100 million to 200 million operations. It is rated for 150 v dc and 220 v ac. **Automatic Electric Co.**, Northlake, Ill.

Circle 449 on Page 161



Metering Pump

Item 450

Applicable in the food and chemical industries, sanitary metering pump with suitable drive has discharge rates from 25 gpm to zero. Pump can handle heavy viscous materials without aeration, crystallization, or product breakdown. Once the unit is set, the discharge rate remains constant, providing steady metering and proportioning. When operating at slow speeds, the impellers form four large chambers in the pump head which draw and discharge four product loads with each revolution.

Features of the unit include easy disassembly for cleaning, replaceable O-ring sealing, and a corrosion resistant pump housing. They can be furnished with fixed and variable speed drives. **Waukesha Foundry Co.**, Waukesha, Wis.

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Temperature Controller

Item 451

Applicable on electrically heated furnaces, instrument is capable of control to a precision of 0.1 F using platinum thermocouples or 0.025 F with base metal types. Model 2HCT consists of a null balance input circuit with manually balanced set point and a highly stable isolated input dc amplifier to amplify temperature deviations. With the use of a dc amplifier with a second harmonic magnetic converter input, the unit provides a high immunity to stray electric pickup. Controller output is ± 10 v for a ± 100 mu v deviation from the set point. This output is sufficient to operate magnetic amplifiers up to 300 w ratings directly which can in turn control up to 100 kva saturable core reactors. **Boston Div., Minneapolis-Honeywell Regulator Co.**, 1400 Soldiers Field Rd., Boston 35, Mass.

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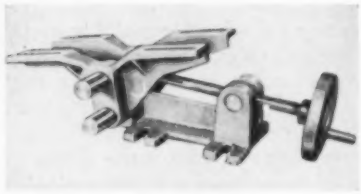


Tilting Motor Base

Item 452

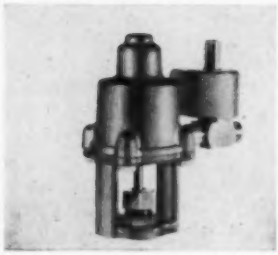
Base is designed for use with variable speed pulleys, is adaptable for all electric motor drive applications ranging from 1 to 3 hp. Unit continuously provides correct belt tensioning, features simple belt changing on cone step pulleys. Speed control is maintained by means of a hand screw adjustment. Motor base fits all NEMA frame sizes, and can be mounted in any position. **Lovejoy Flexible Coupling Co.**, 4984 W. Lake St., Chicago 44, Ill.

Circle 452 on Page 161

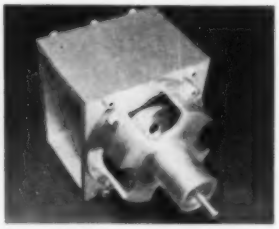
Cylinder with Valve

Item 453

Cylinder is single acting, controlled by a built-in 3-way solenoid valve, and capable of controlling heavy duty levers, latches, and dampers. Unit will operate on air, water, or oil at pressures from 10 to 150 psi. Cylinder is available in two sizes. The $2\frac{1}{2}$-inch size has a cast bronze frame, stainless steel stem, and return spring. Maximum load at 150 psi is 375 lb. The $3\frac{1}{2}$-inch size has a cast iron frame and top plate, stainless steel stem, and return spring. Maximum load at 50 psi is 360 lb. **Automatic Switch Co.**, Florham Park, N. J.



Circle 453 on Page 161

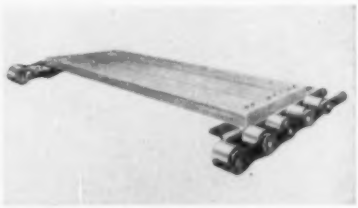


Clutch-Brake

Item 454

Device can be used in clutch-brake combinations, contra-rotation clutches, and double speed clutches, is applicable on spindle valves, stepping switches, counters, and operations with transistors. Model C-400 features an engagement and release time of less than 1 millisecond with full torque of 30 oz-in. at 12 v dc input. Torque output is linear with respect to voltage input, and the unit will operate with as little as 1 v. **Norman Hardy Associates**, P. O. Box 97, Wyncote, Pa.

Circle 454 on Page 161



Conveyor Apron

Item 455

Unit is constructed with heavy wood slats mounted and riveted on large diameter roller chain. The roller chain permits the conveyor

SIX GREENLEE'S ON THIS TEAM

Leading Auto Manufacturer Selects 6 Greenlee Transfer Machines For V-8 Engine Block Precision Machining Line

The entire installation has 127 stations and a machined block comes off the line at each cycle. This first unit drills and reams locating holes, mills main bearings to width; mills lock slots, oil seal and slinger grooves, fuel pump and filter pads and rough bores cylinders. It also has a gauging station to check locating holes, a reject station and three turnover stations, the last of which positions the block for the next machine.

WRITE FOR COMPLETE INFORMATION

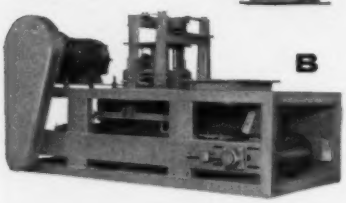
GREENLEE BROS. & CO.

2089 MASON AVENUE
ROCKFORD, ILLINOIS

Circle 706 on Page 161

UNITIZED
WEIGHER-FEEDER

Building-block design gives custom-made utility at an off-the-shelf cost



UNITIZED construction makes the W-C Weigher-Feeder readily adaptable to practically any processing setup. Components are standardized, proven and interchangeable . . . pre-engineered with virtual "plug-in" simplicity.

A The UPPER FRAME controls material input, is supplied with a rotary feeder, sliding gate, vibratory feeder or other mechanism matched to material and flow requirements.

B The CONVEYOR FRAME, where material is weighed, includes a complete conveyor section, weighing pan and transmitter with integral tare adjustment. W-C's system of flexure mountings assures accurate measurement despite uneven loading or pile-ups. There are no knife-edges, beam pivots or other points of concentrated wear to affect accuracy.

C The LOWER FRAME is optional; can be a simple chute as shown.

In addition, the W-C Weigher-Feeder is designed to handle such instrument-controlled functions as flow totalizing, recording, programming, and material proportioning. Units are also available for installation on existing conveyors.

Complete information is given in Catalog 12. Write for a copy

W-C

S.A. 1667

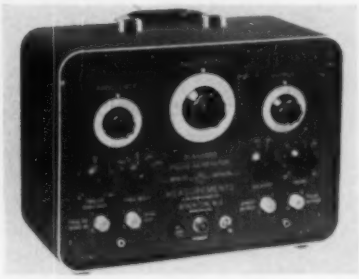
WEIGHING and Control COMPONENTS, Inc.

206-C Lincoln Ave., Hatboro, Pa.

Circle 707 on Page 161

apron to roll freely when upright or in inverted position. The rollers are heat treated to increase the life of the chain. Conveyor apron can be made with wood, steel, aluminum, or plastic slats in widths up to 14 feet and in any length. **Robert A. Main & Sons Inc.**, 257 Pascack Rd., Paramus, N. J.

Circle 455 on Page 161

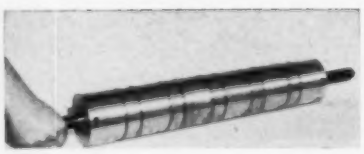


Pulse Generator

Item 456

Suitable for production line testing and other work where pulses of known width and frequency are required, device provides a continuously variable output pulse amplitude. Instrument features a wide calibrated frequency range, high output with short rise time, and calibrated pulse width and frequency controls. Vacuum tube circuitry is used throughout Model 179. A monostable adjusable-width multivibrator is triggered by the internal free-running multivibrator or by external pulses. A limiter and driver amplifier shape the pulse delivered to the output polarity-reversing amplifier. Input and output trigger pulses are fed through isolation amplifiers. The high-amplitude pulses permit direct keying or gating of vacuum-tube plate, grid, and screen grid circuits. **Measurements, Div., McGraw-Edison**, Boonton, N. J.

Circle 456 on Page 161



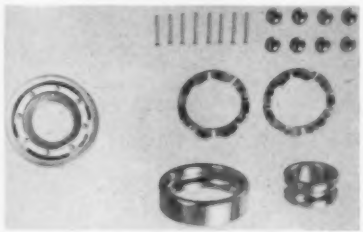
Magnetic Pulley

Item 457

Small diameter nonelectric magnetic pulley is suitable in material handling operations. It is available in two styles—the peripheral (shown) and the transverse pole. The peripheral type pulley is adaptable for conveying, turning, lifting, transferring and holding ferrous materials such as sheets, tubes, bars, rods, and other parts. This style is also suitable for removing lightweight metal parts from a conveyor.

The transverse pole type pulley is applicable as a conveyor head pulley for self-cleaning magnetic separation on bulk materials such as chemicals, foods, and grain. In separation work, the unit can handle burdens up to 1 inch or 1½ inches deep, depending on the type of burden, type of tramp iron, and belt speed. Both styles are available in eleven face widths, ranging from 5 inches to 25 inches, with 4-inch diameter. **Dings Magnetic Separator Co.**, 4740 W. Electric Ave., Milwaukee 46, Wis.

Circle 457 on Page 161



Antifriction Bearings

Item 458

Line of antifriction bearings is suitable for operation in ambient temperatures up to 900 F. Units are available in four sizes—200, 202, 204, and 206. Inner and outer races are M-2 high speed steel. Riveted machined retainer is land riding, is manufactured from either S-Monel or heat treated M-2. Balls are M-10 high speed steel. The radial ball bearings are manufactured to ABEC 3 and 5 accuracy, will operate at speeds up to 40,000 rpm without lubrication. **Industrial Tectonics Inc.**, 3686 Jackson Rd., Ann Arbor, Mich.

Circle 458 on Page 161

DC Power Supply

Item 459

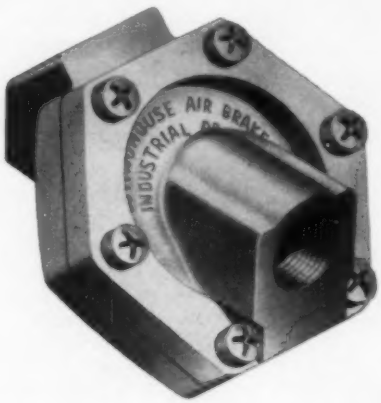
Model 550 features transistor circuitry throughout the unit. The power supply incorporates an over-

New Product Announcement

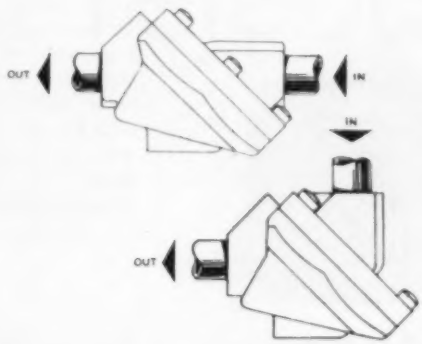
WESTINGHOUSE QUICK RELEASE VALVE

light weight...flexible mounting...more sensitive control

Here is the new Westinghouse Quick Release Valve. Its all-new design features a number of improvements which make it the most efficient device you can use to vent air-pressure cylinders and other pneumatic equipment.



Only 7 ounces!—The Westinghouse Quick Release Valve is made of aluminum—it weighs only seven ounces. It is ideally suited to meet installation requirements where weight is an important factor.



No bracket needed—A key feature of this valve lies in the flexible mounting of its supply port, allowing the inlet and outlet ports to be assembled on the same center line or at right angles to each other. In addition, you need no bracket to install the new Westinghouse Quick Release Valve.

Unmatched response—This new device provides one of the most sensitive controls yet offered in a valve of this type. Because of its design, the Westinghouse Quick Release Valve will respond to pressure changes as low as 6 psi.

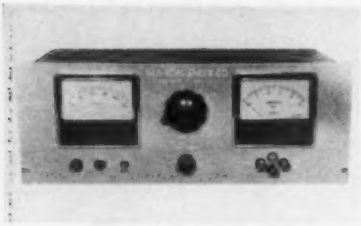
Other advantages—Westinghouse Quick Release Valves have larger internal passages, allowing them to exhaust greater volumes of air quickly and efficiently. These valves have been engineered so that centrifugal force will not affect their performance when mounted on rotating or revolving devices. Constructed of sturdy, corrosion-resistant aluminum, these valves will deliver long, trouble-free performance with minimum maintenance. The diaphragm of the Westinghouse Quick Release Valve is oil-resistant and its special design provides quiet operation.

To speed the operation of any pneumatic circuit, order the new Westinghouse Quick Release Valve from your local distributor. Price: $5.25. Quantity discounts available.

See the yellow pages under Cylinders for the name of your local distributor.

Westinghouse Air Brake
COMPANY
Industrial Products Division
WILMERDING PENNSYLVANIA

Circle 708 on Page 161



load protection that can be preset with a calibrated panel control for protection of the load. Unit also provides for remote sensing of the voltage at the load. Supply is powered from 115 v ac; electrical characteristics are 3 to 45 v continuously variable, zero to 5 amp, output impedance 0.01 ohms, and less than 8 mv ripple. **Sila-Kon Engineering Co.**, P. O. Box 282, El Monte, Calif.

Circle 459 on Page 161

Submersible Motor

Item 460

Adaptable for direct coupling to pumps which must operate continuously while submerged in oil, water, or liquid chemicals, electric motor is available in sizes from ¼ through 15 hp. The mounting flange is designed for direct connection to any pump. The motor and pump assembly can be lowered into mounting position and attached as a single unit. Integrally cast rings at the top edge of the frame provide convenient, balanced handling.

Unit is rated at 55 C temperature rise for 30-minute duty in 40 C air, and for continuous duty in 40 C liquid. A neoprene diaphragm in the motor base flexes slightly to offset minute differences between internal and external pressures, relieving pressure build-up around the positive shaft seal or O-ring seal between the motor frame and mounting bracket. **Reliance Electric & Engineering Co.**, 24701 Euclid Ave., Cleveland 17, Ohio.

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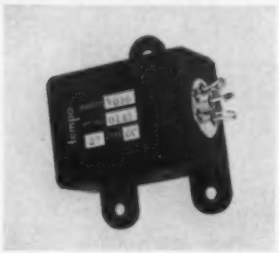
Time Delay Relay

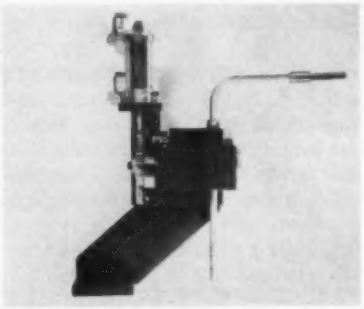
Item 461

Device is all-electronic, uses transistors and time-constant circuit elements, only moving parts are the relay contacts. It is applicable on automatic control circuits, computers, controllers, and communications equipment. Relay is available



with time delay periods from 0.01 to 60 seconds, the delay occurring between application of current and relay contact pull-in. Timing accuracy is ±10 per cent of nominal delay period. Unit will operate on 28 v dc, with contacts rated 10 amp resistive available as 1-pole, double-throw, or 3-pole, double-throw. **Tempo Instrument Inc.**, 240 Old Country Rd., Hicksville, N. Y.

Circle 461 on Page 161

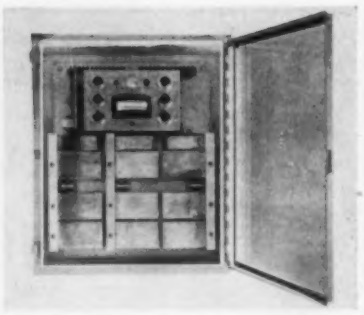


Parts Orienter

Item 462

Unit is capable of sorting and orienting cylindrical parts which are similar in appearance, but have a slight inside or outside diameter variation at one end. Orienter is operated by a cylinder on 60 lb air pressure, can reach speeds up to 150 parts per minute. In operation, the unit accepts the parts at random, when a part is upside down, the orienter turns the part over before letting it proceed in the feeding line. **Peeco Div., Automation Devices Inc.**, Erie, Pa.

Circle 462 on Page 161

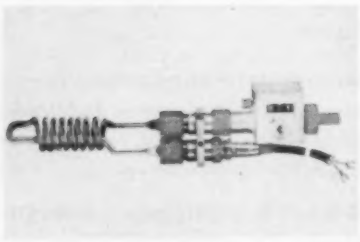


Fractionator Computer

Item 463

Device can be used as an operational aid in process industries, is also suitable for use as an optimizing controller in fractionating towers or distillation columns. In operation, the computer accepts electrical input signals from standard instrument transmitters installed in the process loop. It performs computations designed to maintain output product at desired quality or quantity based on the feed flow rate and product analysis. Distillation column output is computed by summing the product line flows. Input signals are converted to their logarithms, which are then added, subtracted, or proportioned to compute products, quotients, or exponentials. Magnetic amplifiers are used for operational amplifers and aged transistors are used for any memory or switching requirements. Unit is enclosed in a moisture-proof cabinet. **Southwestern Industrial Electronics Co.**, 2831 S. Post Oak Rd., Houston, Tex.

Circle 463 on Page 161



Thermoregulator

Item 464

Designed for temperature control, instrument combines the displacement principle of the ultra micro buret with a glass spiral U-tube. A micrometer screw accurately measures the displacement of a stainless

PRECISION BORING

SAVE 300 HOURS PER UNIT

on precision boring of gear boxes. Each unit (2 halves) calls for over 200 holes from ¾" to 4½" dia. Boring, spot facing, recessing, milling, tapping and counter boring. Material is aluminum alloy.

with no rejects

hole location accurate to ±.0001"

hole sizes repeated to ±.0001"

Boring time reduced from 800 hours to 500 hours per unit—with no rejects in all 50 parts—and every one accurate to ±.0001" on hole size and location! Over 200 holes per unit are machined.

Mr. R. Schmidt of Triangle Tool Co., Union, N. J., owner of this Fosmatic Jig Borer, reports, "Two Fosmatic features were largely responsible for this important time saving. First, the Fosmatic's long table travel permitted machining two parts at once. Second, the automatic positioning and Direct Dimension Measuring System work simply and fast. They eliminate confusion and help the operator work accurately and efficiently. Incidentally, that long table travel helped get us several new jobs we could never have handled on our other jig borer."

With Direct Dimension Measuring the operator sets dimensions direct from blueprint onto two direct reading drum dials. At the press of a button, the table automatically positions work to ±.0001". On the Fosmatic, this operation and all other machine functions can be numerically controlled by punched tapes or cards.

Fosmatic Jig Borers bring you many important advances in boring technology. Where progress has been so great, the obsolescence of your old machine may be more costly than you suspect. *Why not run a check?* Call your Fosdick Distributor or write us today.

Ask for Fosmatic Jig Borer Bulletin JB-P

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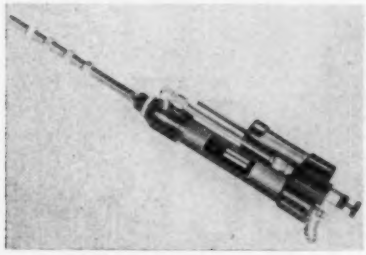
steel plunger entering an exact mass of mercury, and operates a mechanical counter which reads the exact temperature of control. Accuracy is said to be better than 0.1 C. Range of the instrument is met by a secondary larger plunger, anywhere from −35 to 200 C in 100 C intervals. The counter covers 100 C in 0.02 C divisions, with readability to 0.01 C. **Emil Greiner Co.**, 20-26 N. Moore St., New York 13, N. Y.

Circle 464 on Page 161



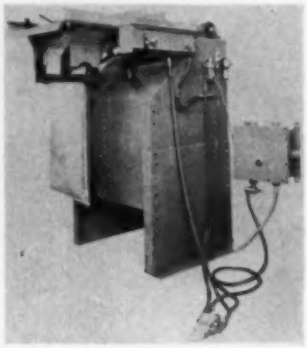
Hydraulic Power Check

Item 465

Applicable on work holding devices, assembly fixtures, and production machines, unit is designed to provide an adjustable opposed force to the movement of a machine element, such as the feed on drill presses, lathes, etc. When applied to pneumatic cylinders it decreases chatter or flutter, giving uniform feed which is unaffected by variations in power thrust.

Model 3000 includes an oil filled checking cylinder, a checking piston, adjustable metering valve, and reservoir cylinder. It is installed by attaching the cylinder to a fixed portion of the machine and the piston rod to the member to be controlled. In operation, as the piston rod is pulled out, the piston in the checking cylinder forces oil through a metering valve and back into the opposite end of the checking cylinder. On the piston rod return stroke, a one-way valve automatically opens to permit oil to flow freely through the piston check valve. A spring loaded balance cylinder is located in the circuit to provide a reservoir for oil displaced by the piston rod. Unit is capable of handling loads up to 3000 lb, is available in 13 sizes with strokes from 2 to 20 inches. Cylinder bore is 1.385-inch on all models and piston rod diameter is ½-inch on models with stroke up to 6 inches. On larger models, piston rod diameter is ⅝-inch. **Appco Corp.**, P. O. Box 6, Olmsted Falls, Ohio.

Circle 465 on Page 161



Bag Release

Item 465

Automatic device is designed for any bagging scale with a universal air-operated bag holder. Unit is air-operated, can be used with textile and paper wall bags. When the operator puts the bag on the spout, he presses a reversible foot pedal which closes the bag holder and the discharge circuit of the scale. At the finish of the weighing operation, the scale discharges into the waiting bag. This action initiates the timer operation. At the end of the timing cycle, the bag holder opens to release the filled bag. The foot pedal and timer then reset themselves for the next operation. **Richardson Scale Co.**, Clifton, N. J.

Circle 466 on Page 161

Electronic Voltmeter

Item 467

Miniature panel-mounted electronic voltmeter is suitable for applications where voltage in a circuit must be measured without im-

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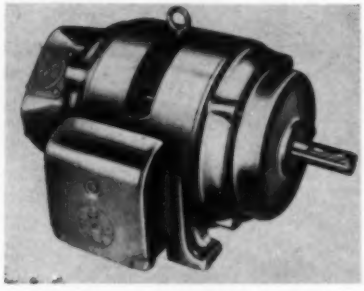
Circle 710 on Page 161

posing an additional load which would change the characteristics of the circuit. It can also be used where voltage reflects some other quantity such as pressure, temperature, speed, or displacement. The multirange units are available in ac or dc. They can be operated with either or both signal input terminals isolated from ground. The dc voltmeter is furnished in seven voltage ranges from zero to 1000 v. Accuracy is ±3 per cent. AC voltmeter has a broad frequency response from 20 cps to 100 kc. Full scale ranges are provided in 10 db steps from 10 mv to 300 v. **Metronix Inc.**, Chesterland, Ohio.

Circle 467 on Page 161

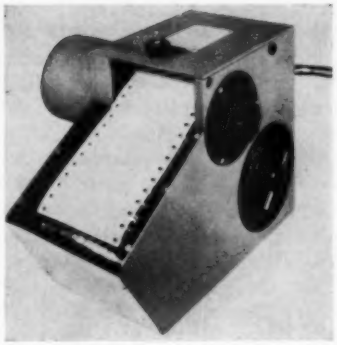


Capacitor Motor

Item 468

Single-phase, 60 cycle induction motor is available from ¾ hp to 1½ hp at 1200 rpm, 1 hp to 3 hp at 1800 rpm, and 1½ hp to 5 hp at 3600 rpm. It is suitable for applications requiring a high starting torque, such as on pumps, fans, drill presses, and lathes. In operation, as the motor gains speed, a centrifugal switch cuts out the capacitor for straight induction run. The switch is designed with over-size snap action contacts, and can be replaced without disturbing the actuating mechanism or any other part of the motor. A copper spun rotor (complete with shaft, ventilating fans, and switch mechanism) provides vibrationless operation. The stator core is constructed with silicon steel sheets; the slots are insulated with heavy paper and varnished cambric slot cells to protect and support the coils at the end of the slots. **Fairbanks, Morse & Co.**, Fairbanks-Morse Bldg., Chicago 5, Ill.

Circle 468 on Page 161



Recorder

Item 469

Multi-channel instrument records data such as machine down time, occurrence of defects, and machine failure. It is applicable in textile, processing, plastic, and rubber molding industries, and machine tool and assembly operations. The unit, which records the data on paper, is available in two sizes; one has 68 recording channels, the other has 44 channels. The marking is made on electrically sensitive paper and paper speeds of 2, 4, 8, 16, and 32 inches per hour can be obtained. The paper is ruled in divisions representing time intervals. The instrument includes a power supply and multi-channel recording heads. It can be connected to switches, relays, or other power interrupting devices which can be remotely located. **Lindly & Co. Inc.**, 248 Herricks Rd., Mineola, N. Y.

Circle 469 on Page 161

Memory Unit

Item 470

Designed for moderate bit capacity, device is adaptable to a continuous process system. Model 603-A includes 60 condensers mounted

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Circle 741 on Page 161

on a rotating wheel, with suitable charging and pickoff brushes. Memory storage is accomplished by charging selectively any one of the condensers. Charging and pickoff can be continuous, or the drive shaft can be indexed to each condenser by a servomechanism.

In operation, an external potentiometer is excited with direct current and driven mechanically by the quantity to be stored. The pot wiper feeds the charging circuit of the unit, while the movement of the sample drives the shaft. The condenser energized retains its charge until the shaft rotation brings it under the pickup brush. The original analog voltage, proportional to the measured quantity, is then available for circuit control. Maximum charging voltage is ± 200v dc, maximum shaft speed, 300 rpm, and maximum storage time, 3 minutes. **Industrial Control Co.**, 805 Albin Ave., Lindenhurst, L. I., N. Y.

Circle 470 on Page 161

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Filter/Separator

Item 471

Applicable in paint spray operations, unit is capable of removing all dirt, scale, and moisture from both line air and regulated air. Features of the air filter and water separator are two regulated air valves which permit use of two spray guns operating on different pressure settings. Line air pressure is also available through two additional valves. A porous bronze filter traps all foreign particles. Only one air filter is required for the pumps and spray guns. **Gray Co. Inc.**, 1005 Sibley St. N.E., Minneapolis 13, Minn.

Circle 471 on Page 161

Digital Load Indicator

Item 472

Instrument provides accurate measurement of weight, torque, thrust, and pressure in laboratory and production applications. Model DLI-2 uses a precision null balance servo system. Presentation in the form of large digits can be read to one part in 1,000 at a distance of 10 feet without interpolation.

Circuit arrangement allows up to ±50 per cent variation in steady state bridge supply voltage with no change in zero or span. Instrument accuracy is ±0.15 per cent. Standard slidewire linearity is ±0.1 per

cent. Indicator accepts all standard 4-arm strain gage transducers of 120 or 350 ohms resistance. Unit is rated for 115 v ac, 60 cycles. **Performance Measurements Co.**, 15301 W. McNichols, Detroit 35, Mich.

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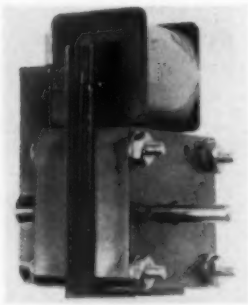

Instrument Motor

Item 473

Capable of operating light shutter discs or small fans, subfractional-watt instrument motor can also be used wherever size and power drain are factors. The rotor of Model B is a permanent magnet disc actuated by a stationary field coil. Commutation of periodic field flux reversal is attained by a nylon roller cam, actuating a spring contact assembly. Neither revolving windings nor sliding commutator contacts are used in the device. Motor operates at a current input of 12 ma at 4½-6 v dc. **Brailsford & Co. Inc.**, 670 Milton Rd., Rye, N. Y.

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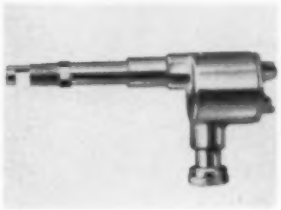

Liquid Level Sensor

Item 474

Device is applicable in petroleum, chemical processing, and food processing industries where constant fixed position monitoring of the presence or absence of liquid is required. It is capable of operating in water, acids, alkalies, oils, and viscous liquids. Using a radioactive material in the sensing element, the sensor provides an actuating signal to control or indicate a predetermined level.

The unit includes a small sensing probe which can be mounted in any position and can be connected by up to 200 feet of cable to an amplifier. A relay in the amplifier can be used to operate remote warning devices or motor starters, valves, or timing devices. A beta ray detector tube and the permanently sealed source of beta radiation are mounted in the probe. When the liquid level is below the probe position, beta particles sent from the radioactive source pass with a minimum of absorption to the detector tube where a pulse train is produced and transmitted to a thyratron tube in the remotely located amplifier. Integration of these pulses in the amplifier produces a signal which energizes a relay. When the probe position is covered by the liquid, beta radiation is absorbed by the material, reducing the pulse rate at the detector to a level which de-energizes the relay. Unit is rated for 105-125 v ac, 60

Part: Carburetor economizer diaphragm valve.
Operation: Gaskets and diaphragm cut from reel stock. Seven parts assembled.
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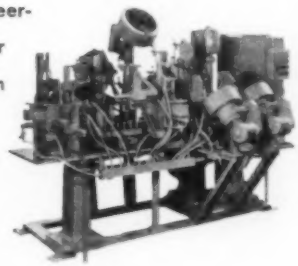

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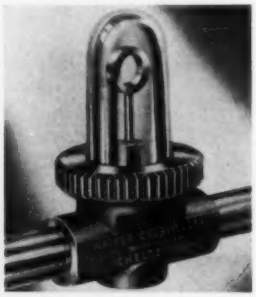
Circle 712 on Page 161

cycles. Probe temperature range is −65 F to 220 F, amplifier range from zero to 135 F, probe operating pressure range from vacuum to 800 psig max. Accuracy is stated as ±0.05 inch when mounted horizontally, and ±0.10 inch when mounted vertically. **Robertshaw-Fulton Controls Co.**, 401 N. Manchester, Anaheim, Calif.

Circle 474 on Page 161



Flow Indicator

Item 475

Unit features a glass dome for visible indication of flow. It is applicable in lines for cooling water to electronic equipment, jacketed vessels, compressors, condensers, and engines; for cooling oil to transformers; and for lubricating oil to bearings and gear trains.

In operation, the liquid, as it passes, spins a chromium plated ring under a glass dome. If the flow stops, the ring stops spinning. The warning can be seen from a distance, even in dim light. Indicator is available in ½-inch, ¾-inch, and 1-inch pipe sizes for flows from 0.72 to 24 gpm. **Walker Crosweller Div., McIntosh Equipment Corp.**, 15 Park Row, New York 38, N. Y.

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Switching Amplifier

Item 476

Applicable with various types of sensing elements and relays, amplifier is a high gain temperature control device for applications requiring on-off switching action. With a suitable relay about 2 ma differential input signal is sufficient for relay operation. Model SA6A-1 contains three legs of a Wheatstone Bridge, an external connection for a sensing element makes up the fourth leg. Also included is a connection for the external potentiometer which sets the temperature control point of the system. Unit is rated for 115v, 60 cps, temperature operating range from −67 to +200 F. **Magnetic Controls Co.**, Dept. KP, 6405 Cambridge St., Minneapolis 16, Minn.

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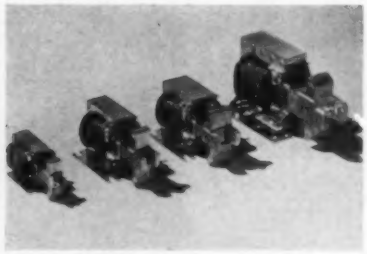

Solenoids

Item 477

Units are available in four sizes, in 12 different models, with stroke lengths ranging from ⅝-inch to 1⅜-inch. Designed for constant or intermittent duty, the units feature a double TT plunger construction which permits the use of a large air gap between the plunger stem and the extremities of the frame legs. This results in almost level pull characteristics throughout the plunger stroke. As the plunger stroke decreases, the gap in the frame is bridged by an extra T section on the double TT plunger. Units are rated for 110 or 220 v. **Soreng Div., Controls Co. of America**, 9555 Soreng Ave., Schiller Park, Ill.

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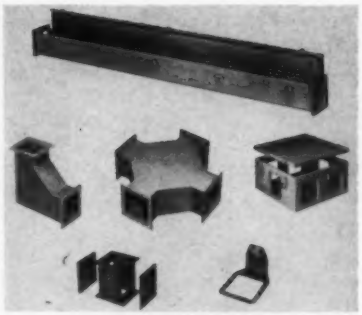
Wireways & Fittings

Item 478

Designed for use on wiring installations which require special protection against oil, dirt, dust, and water; wireways and fittings are constructed of 14 gage sheet steel with 11 gage steel flanges seam



welded to the ends of each section. The hinged covers and the ends of the wireways are fitted with positive-sealing neoprene gaskets and external latching type clamps to provide a liquid-tight installation.

The wireways are available in four sizes, in lengths from 1 through 4 feet. Types of fittings include elbows, square and cross pull boxes, nipples and junction boxes, gaskets, and closing plates. **Keystone Mfg. Co.**, 23328 Sherwood Rd., Warren, Mich.

Circle 478 on Page 161

Decade Inductor

Item 479

Adaptable for use in analog computers, network design, and laboratory applications, low frequency decade inductor features a micrometer adjustment which permits precise settings. Unit has maximum values of storage factor Q in excess of 300. Coil windings of the decade inductor are impregnated for stability and moisture resistance. Each decade is housed in a drawn aluminum carrying case for electrostatic shielding and mechanical protection. Unit is available in three decades (0.01h to 0.1h; 0.1h to 1h and 1h to 10h) which can be combined to permit switching in any value of inductance from 0.01h to 11.1h in 0.01h steps. Accuracy is within 0.1 per cent of nominal

value at 100 cps. DC resistance is 2.25 ohm/henry maximum. **Computer Engineering Associates Inc.**, 350 N. Halstead Ave., Pasadena, Calif.

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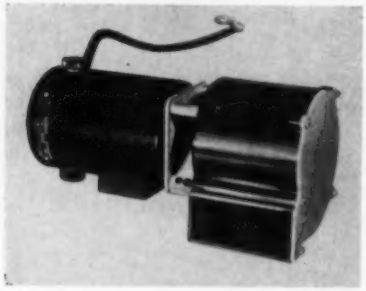
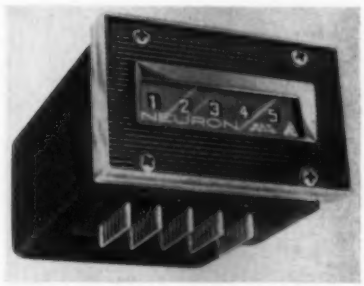


Centrifugal Blower

Item 480

Line of centrifugal air moving units is suitable for cooling electronic equipment, radio and TV transmitters, and electric motors. The different styles have single or double inlets, single or double wheels, direct or V-belt drive, and offset or direct discharge. The miniature model shown (used to cool electronic tubes in a communication transmitter) delivers 80 cfm at 1.5 in. w. g. static pressure. Blower is operated by a 1/10 hp motor at 8000 rpm. Blower can operate at static pressures as high as 4 in. water gage. **American Blower Div., American-Standard**, Detroit 32, Mich.

Circle 480 on Page 161

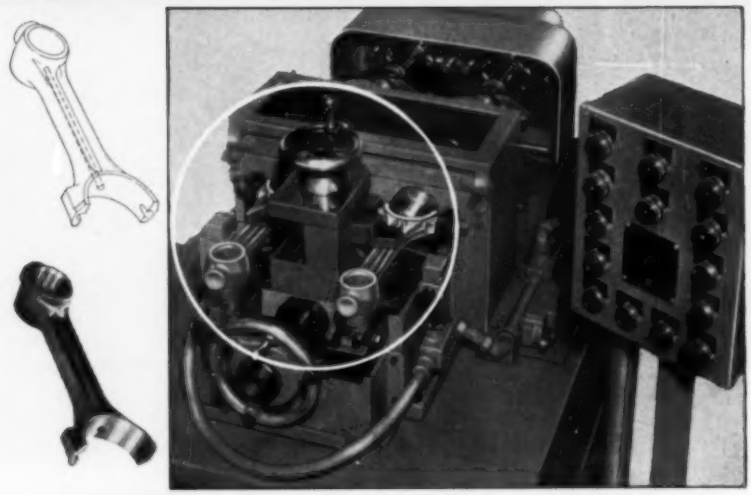


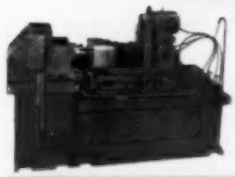
Switch Readout Counter

Item 481

Electromechanical readout counter provides switch readout function on each point of its five digital wheels. Counter has a life of 300,000,000 counts, features rates to 40 counts per second. It is available with either manual or electrical in-

standard gun drilling machine





- **Assures Concentricity, Size and Finish**
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amazingly versatile

This Standard Machine can be adapted for various depths, and for various size holes, with the smallest amount of fixturing. Concentricity, size, and quality of finish is no longer a problem in any hole—deep or shallow.

completely automatic

Except for load and unload, the entire operation of this New Gun or Deep Hole Drilling Machine, is completely automatic. Automatic load and unload can be provided as an extra feature, if so desired.

torque drive adapter

A Torque Drive Adapter, with contact switch, protects the cutting tools from breakage. If dull drills, or improper grinding, cause excessive torque, feed and rotation of the spindle stops, and it returns to the back position.

coolant under pressure

During the entire operation, clean, filtered cutting oil is delivered to the end of each rotating spindle, under pressures from 75 psi to 1500 psi.

standard specifications

Available speeds 2000 to 8000 rpm. Gun drill diameters .187 to .750. Feed rate .0001 to .010 per/revol. Feed stroke 1.00" to 12.00". Maximum stroke of 20" for tool changes. For longer strokes and for larger drill sizes, other models are available.

For Complete Details Call or Write

CRESCENT

TOOL & MACHINE COMPANY, INC.

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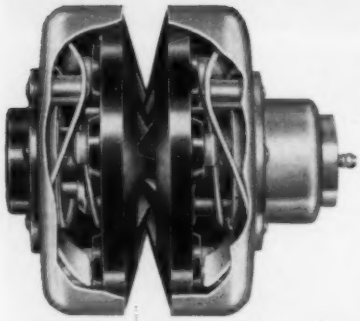
Circle 713 on Page 161

Hi-Lo Load-O-Matic Control Eliminates Pulley Slow Down



Hi-Lo Variable Speed Pulleys positively maintain the desired speed ratio over a wide range of load variation by means of an exclusive cam and cam follower assembly. This means:

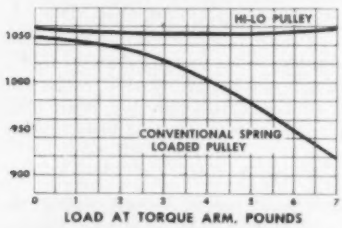
Pulley speed is independent of load and load changes. "Drag" is eliminated and high shock absorbency provided.

Pulleys do not compress belt due to spring pressure. Springs are not driving members. They act only to keep pulley faces in contact with belt.

Pulleys automatically regulate belt tension. Because of the cam assembly, belt is never under more tension than required by the load.

Double cams maintain constant belt alignment.

HI-LO PULLEYS COMPARED TO OTHER VARIABLE SPEED PULLEYS



PLUS THESE OTHER FEATURES:

- Smaller in size than comparable units.
- Quickly and easily installed.
- Replaceable face assemblies drastically cut repair and replacement costs.
- Available in sizes from .5 to 5 hp., ratios to 2.5/1 (single pulley) 6.25/1 (double pulley).

Request details and prices. Ask for Bulletin A-458.

Manufactured By HI-LO MANUFACTURING COMPANY

Nationally Distributed By LOVEJOY FLEXIBLE COUPLING COMPANY 4956-H W. Lake St. Chicago 44, Ill.

Circle 714 on Page 161

stantaneous pulse reset. A bidirectional stepping mechanism prevents double-indexing during shock, vibration, or over-voltage. Static switch current capacity is 1 amp and the dynamic switch current capacity is 100 ma. Models are available which respond to a variety of ac and dc actuation voltages. **Autron Engineering Inc.**, 1254 W. Sixth St., Los Angeles 17, Calif.

Circle 481 on Page 161

Electronic Integrator

Item 482

Instrument includes a servo amplifier, a velocity-tachometer, and a power supply. It is suitable for integrating voltage with respect to time for measurable quantities such as rate of flow of liquids, and for use with continuous weighing devices. Integrator incorporates a velocity-servo principle, and features rapid frequency response, stability, and linearity. **Bell Automation Corp.**, Rochester 7, N. Y.

Circle 482 on Page 161

Stepping Motor

Item 483

Motor is designed to rotate an external shaft and connected load through any specified angle up to 36 degrees, in response to a pulsed electric input signal. It can be used as a remote positioning device for optentiometers, shafts and switches; as a counter in computer and telemetry applications; as a remotely controlled indicator; or as an incremental torque transmitter.

Unit will accept consecutive command pulses from either of two independent sources in any order. The resulting successive shaft steps can be continuously clockwise or counterclockwise. Motor can be servo mounted, will operate at temperatures ranging from −65 F to +160 F. Input voltage is 28 v dc. **Clary Dynamics**, 408 Junipero St., San Gabriel, Calif.

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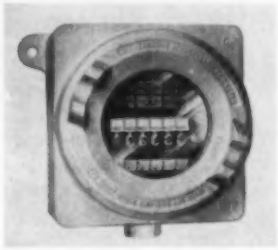


Miniature Annunciator

Item 484

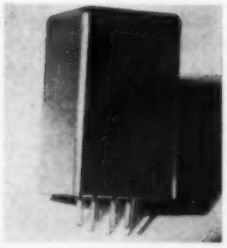
Explosion-proof annunciator is suitable for remote locations in processes where the source of trouble must be identified and recorded. Model ST-EM has two bulbs in parallel for each of the six alarm points to provide constant monitoring. The static switching circuit contains silicon diodes and thermistors, has no moving parts. Annunciator is rated for 120 v, 60 cycles. **Scammit Div., Scam Instrument Corp.**, 1811 W. Irving Park Rd., Chicago 13, Ill.

Circle 484 on Page 161

Logic Element

Item 485

Line of transistor logic circuits and networks is designed for 100 kc operation, is suitable for use from −55 C to +75 C. They contain all circuit types required for synthesis of digital systems, including power supplies and clock generators. Included in the line are flip flops, one shots, diode *And* and *Or* gates, pulse amplifiers, pulse formers, time pulse generators, and power supplies. Circuits are packaged in encapsulated plug-in modules for in-



line or 9-pin miniature tube socket mounting. Accessible test points and terminal layout provide convenient installation and servicing. All circuits operate from ±18 v and ±6 v, with logic levels of zero and −6 v. **Epsco Components**, 108 Cummington St., Boston, Mass.

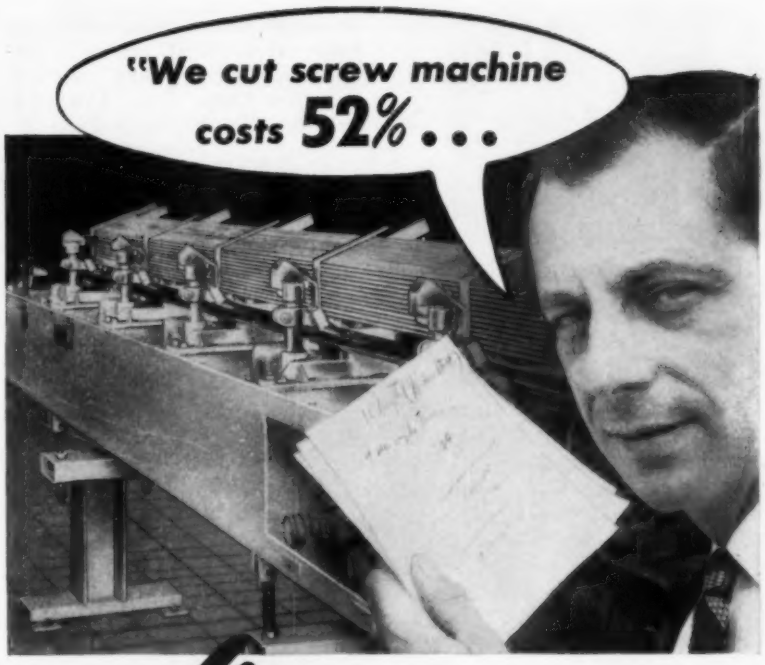
Circle 485 on Page 161

Pressure Gage

Item 486

Instrument is suitable for industrial applications where steam, water, and noncorrosive oils and gases are the principal media measured. Accuracy is within 1 per cent of scale range for the working half of scale, for the remainder, accuracy is 1½ per cent of scale. Movement which translates Bourdon tube motion into pointer position, is available in deep-bushed brass and all-stainless steel. The possibility of pointer shift due to stresses at the gage connection is eliminated by the construction of the unit; the socket, tube, tip, movement, dial, and pointer are constructed as one unit. This feature also provides easy access for inspection, maintenance, and recalibration. Dial sizes are 3½, 4½, 6, 8½, and 12 inches. Pressure range is from 10,000 psi gage down to 30 in. Hg. vacuum. Compound pressure and vacuum ranges are also available. **U. S. Gage Div., American Machine and Metals Inc.**, Sellersville, Pa.

Circle 486 on Page 161



WITH Lipe Automatic
Magazine Loading Bar Feeds

*says Production Supervisor J. H. Lindsey**

● When we were asked to cut costs to meet or beat competition five months ago, we decided to give the Lipe A.M.L. Bar Feed a try. We had heard that this feeding device enabled screw machines to deliver more than 90% of gross geared capacity. We had never done better than 75% with ours, even when new. In the first full week of bar feed operation, the machine to which the A.M.L. was attached *produced 146% more pieces than it had ever turned out before!*

● The A.M.L. fed stock *continuously*, with no repeat motion for feedouts . . . no down-time for changing feed-fingers, or for remnant disposal. There was no cutting air—and when you stop cutting air, you start cutting costs.

● As a result of this test, we installed an A.M.L. on every screw machine in the production line, with the exception of those we were able to eliminate because of the overall increase in output. When we come to install new machines, the A.M.L.'s will be there to develop *their* extra potential.

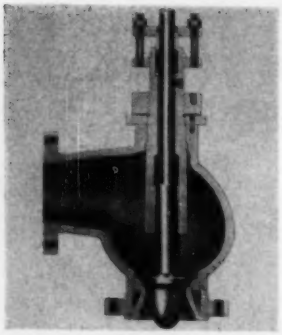
Write or Wire for a FREE Lipe Sales Engineering estimate of production increases, savings and amortization time of Lipe A.M.L. Bar Feeds in your production layout.

*Photographer's models and pseudonyms used to protect company identity and confidential information.

Lipe-ROLLWAY CORPORATION SYRACUSE 1, N. Y.

Manufacturers of Automotive Clutches and Machine Tools

Circle 715 on Page 161



Control Valve

Item 487

Capable of handling pipeline gases, steam, and water; control valve is available in sizes ranging from 1 inch to 14 inches, with pressure ratings up to 2500 psi. Unit features a self-sealing bonnet, oversized stem and stem guides, Venturi seat ring, and parabolic plug. In the smaller size, the valve has a pneumatically positioned power actuator which provides sensitive valve throttling in response to 3-15 psi instrument signals. In the larger size, valve is constructed with a Rotomotor actuator, which makes it capable of handling high dynamic forces. It can handle valve stem loads up to 60,000 lb, with precision, sensitivity, and stability. **Conoflow Corp.**, Dept. D-4, 2100 Arch St., Philadelphia 3, Pa.

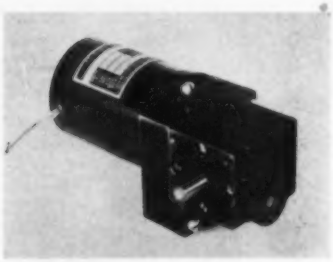
Circle 487 on Page 161

Shaft Mounted Reducer

Item 488

Unit is available with capacities from ¼ to 40 hp, in single (shown) and double reductions with output speeds from 10 to 420 rpm at 1750 rpm input. Reducer features adjustable torque arms and locking collars at each end of the hollow shaft to maintain the reducer in correct position. Stock bushings are furnished in standard sizes, to adapt the hollow shaft of the reducer to the drive shaft of the equipment. Optional equipment available is an interchangeable automatic overload release torque arm, which protects driven machines, motors, and the reducer from excessive shock and overload by simultaneously loosening the drive belt and interrupting the electrical drive circuit. **Foote Bros. Gear & Machine Corp.**, 4545 S. Western Blvd., Chicago, Ill.

Circle 488 on Page 161



Gearhead Motor

Item 489

Device is designed for right angle applications, is rated for 115 v ac, 60 cycle, single phase or 220 v ac, 60 cycle, three phase. For single phase operation the capacitor run motor can be furnished as a hysteresis-synchronous type or induction type. Gear reducer includes one or two stages of worm gear reduction. Output torque depends on the reduction, the motor having a nominal torque rating of 1 in.-oz. Motor is available with 2, 4, or 6 pole windings. **Globe Industries,** 1784 Stanley Ave., Dayton 4, Ohio.

Circle 489 on Page 161

Calibrator

Item 490

Adaptable for calibrating instruments which use resistance type force and pressure cells, unit is a substitute for the sensing element in a measuring system. Rated on a

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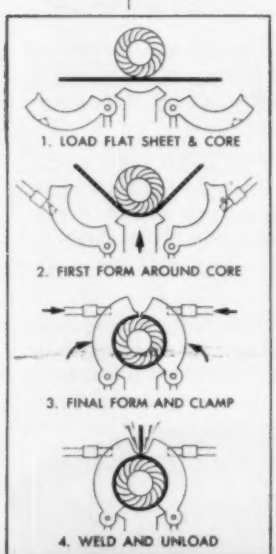
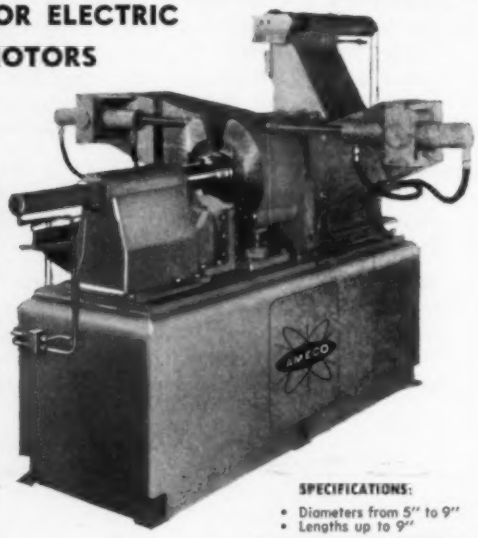
FOR ELECTRIC MOTORS





SPECIFICATIONS:

- Diameters from 5" to 9"
- Lengths up to 9"
- Thicknesses from 16 ga. to 1/8"
- Production 120 to 200 per hr depending on size.

Some choice territories are open for energetic representation

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Circle 716 on Page 161

voltage output ratio basis, these known outputs can be used in calibrating, servicing, and installing indicating or recording instruments. Model 104 is furnished in three styles supplying a maximum output voltage of 0.002, 0.004, and 0.008 volt/volt. Output voltage from the calibrator can be selected in ten equal steps from zero to the rated output of the unit. Voltages are within 1/10 per cent of the rating over an operating temperature of 40 to 100 F. Unit can be used on frequencies up to 1000 cycles. **Gilmore Industries Inc.**, 13015 Woodland Ave., Cleveland 20, Ohio.

Circle 490 on Page 161

Micro-Miniature Relay

Item 491

Developed for use in printed circuit equipment, hermetically sealed micro-miniature relay is designated Type GS. Other applications are found in the electronic field. The 0.2-inch spacing of relay terminals conforms with the 0.1-inch spacing on printed circuit boards.

The double-pole, double-throw unit has a coil resistance of 600 ohms for 26.5 v dc circuits, and can operate over a 190-degree ambient temperature range from − 65 C to 125 C. Relay can withstand vibrations up to 2000 cps at 20 G's and in excess of 50 G's shock tested for Mil-R-5757C. Relay contacts are rated 3 amp resistive load at 28 v dc or 115 v ac for 100,000 operations and 2 amp resistive at the same voltages for 500,000 operations. Operating time with normal voltage applied to the coil is four milliseconds nominal, and the release time is 2.5 milliseconds nominal. **General Electric Co.**, Schenectady 5, N. Y.

Circle 491 on Page 161

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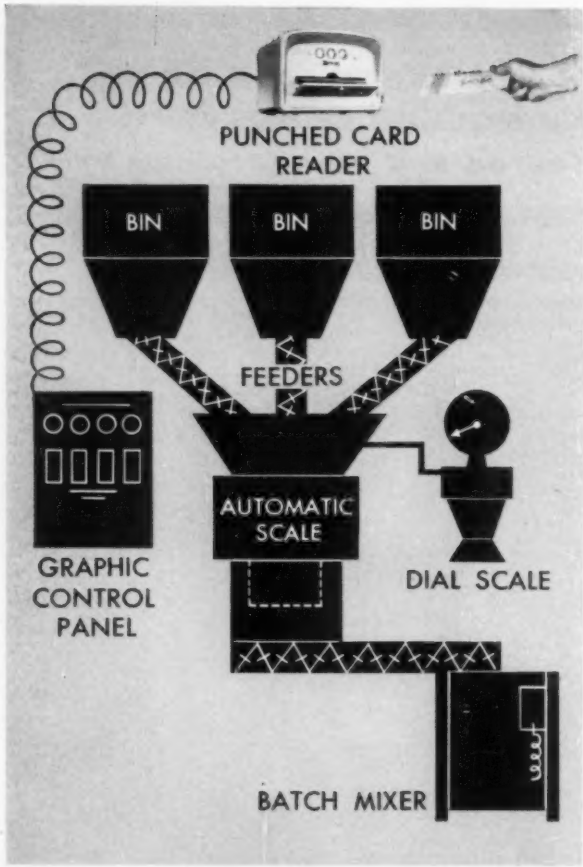
Circle 717 on Page 161



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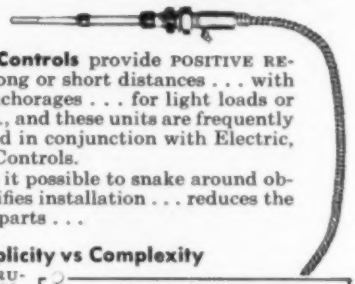
Circle 718 on Page 161

Improved Operation of literally hundreds of mechanical products has been effected with Acco Tru-Lay *flexible* PUSH-PULL Controls

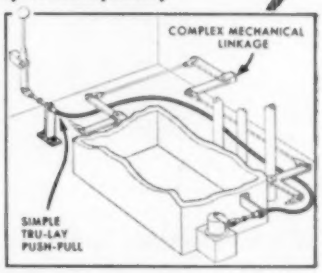


Tru-Lay Push-Pull Controls provide POSITIVE REMOTE-ACTION over long or short distances . . . with fixed or movable anchorages . . . for light loads or loads up to 1,000 lbs., and these units are frequently and successfully used in conjunction with Electric, Hydraulic and Air Controls.

Flexibility makes it possible to snake around obstructions . . . simplifies installation . . . reduces the number of working parts . . .

Simplicity vs Complexity

Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased backlash, lost accuracy and vibration rattles.



Positive Remote-Action and Flexibility, together with Precision and Long Life, explain why TRU-LAY PUSH-PULLS serve designers and users equally well in improving machine operations, whether the application is on such severe service jobs as Bulldozers, Power Shovels and Steel Mill Machinery, or on such light duty work as Photographic Equipment, X-Ray or Business Machines.

Immunity to Vibration makes these TRU-LAY PUSH-PULLS ideal as Remote Controls on shakers and other vibratory products.

Complete Protection Against Dirt and Moisture is a big factor in the use of this unit on machinery in Coal Mines, Cement and Steel Mills, Oil Fields and in many other industries.

Corrosion-Resistance of the unit, plated or with Stainless Steel construction as required by the use, has led to many applications in the Marine Field . . . salt water or fresh. Supplied with a rubber cover the unit operates effectively even when conduit is COMPLETELY IMMERSED.

Lubrication of the inner working member is for life.

Temperatures as low as —70°F will not hinder the proper operation of this unit, and it is thoroughly effective even in the extreme high temperatures encountered on Jet Engine, Furnace Door and Glass Furnace Damper control applications.

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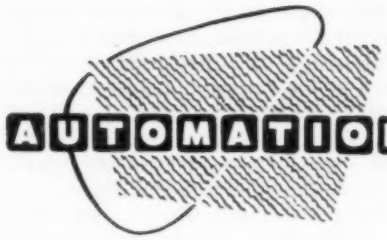

abstracts

INSTRUMENTATION TODAY

By ALLEN V. ASTIN
Director, National Bureau of Standards
Washington, D. C.

MUCH OF the attention which has been focused upon automation in recent years is primarily due to the opportunities which have been opened by developments in instrumentation. In spite of popular impressions, automation is an old concept. But it does have new and extensive areas of application primarily because of advances in such instrumentation specialties as automatic computation and servomechanical systems.

Major changes have already been wrought in our economy. In a technological sense, American industry is very different from what it was a quarter of a century or even a decade ago. I believe that the field of instrumentation can take major responsibility for this technological change.

Growing Industry

A review of data issued by the Department of Commerce's Office of Area Development on the growth of the instrument industry in the United States shows substantial expansion patterns. Using 1947 as a base year, one finds that by 1954 America's scientific instruments industry was shipping 395 per cent more manufactured products than it did in the base year. In the field of optical instruments and lenses, the increase was 159 per cent over the base. In certain selected subcategories, such as aircraft flight instruments, there had been an increase of more than 1750 per cent. It is reasonably certain that since 1954 there has been continued expansion in the area of instrumentation, especially since more and more areas of technology find it necessary, on a competitive level, to incorporate the latest devices and instruments into production and development processes.

Despite this almost phenomenal growth in the instrument industries there seems to remain an excellent opportunity for further expansion, especially into those areas which have not benefited from new measurement devices. In some cases, economic and industrial expansion of the instrument sciences must await initial and important instrument research. The sequence of industrial instrument expansion into new fields seems to be: First, to provide the instruments for exploration of a new scientific area; second, to provide the instruments for introducing this new area into our technology; and finally, to provide the instruments for exploitation of the new technology.

Major Technical Needs

One of the areas of critical scientific need is in the high-temperature field. We are lacking in standards, instruments, measurement techniques, and materials data which better instruments would make possible. The past decade has seen a major industrial shift to high-temperature production and products. This and the needs of other services have brought overwhelming requirements for new basic data, new heat-resistant materials, and new types of instruments and measurement techniques which can operate at temperatures in excess of 1000 C.

Congress has recognized the seriousness of the situation and earmarked funds to begin overcoming the problems. To answer the challenge fully, however, will require an effort beyond that which the Bureau can muster at this time. It is especially important that instrument and scientific apparatus manufacturers help to provide the devices necessary to mount a full-scale attack upon the problem.

Another area where there are major unsolved instrumentation and measurement problems is that of high pressure research. The rapid spread of high-pressure research in this country and the increasing industrial use of high pressures in product synthesis is recognized. It is entirely likely that super-pressure will ultimately yield additional new forms of matter of scientific and industrial interest.

Here, then, is a situation very like that of high temperature. We are at the brink of new scientific developments and ultimately these will lead to industrial applications and new products. Again, the obstacles to efficient progress are those of lack of physical standards, techniques of measurement, and instrumentation.

Another technical area where there exist major unsolved instrumentation problems is that of direct force measurement. The Bureau is developing plans for extending its calibration services for force measuring devices as well as seeking to activate plans for providing direct measurement of load-cell systems and other devices up to one million pounds. The provision of such direct calibrations, of course, must await considerable expansion of the Bureau's present deadweight capabilities. In the meantime, the Bureau will assist all force-measuring instrument organizations with technical advice and related calibrations in order to serve the present and growing need.

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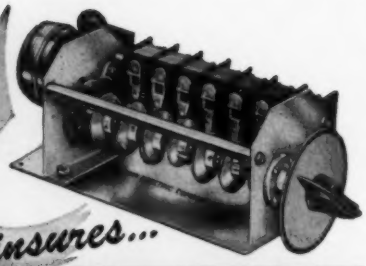

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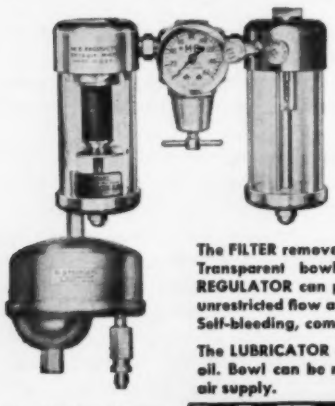

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Still another area where major unresolved instrumentation problems exist is that of electronic measurement devices for use at ultrahigh and microwave frequencies. About two years ago, the Boulder Laboratories of the National Bureau of Standards conducted a survey of the electronics industry in order to gauge the extent of need for calibration services and standards. The need was so extensive that the Bureau will place strong emphasis for several years to come upon the development of new and improved radio standards.

There are, of course, many other technological areas which deserve the attention of the instrument sciences. Among these it might be worthwhile to mention three. The first of these is that of reliability. As operating instrumentation systems become more complex, and as these systems become an intricate maze of interdependent components, the problems of estimating system life-expectancy and reliability become extremely difficult. This is a special problem area, for the performance of any one component becomes, in a sense, a function of almost every other component.

The second problem is that of miniaturization. We recognize the need for size reduction in instruments and instrument systems, but it is essential that we achieve such reductions without any significant sacrifice in operating efficiencies.

The third area of concern is that of training and educating scientists for instrumentation. While instruments and measuring devices have a general applicability to all of science and technology, scientists in other fields look upon these merely as tools. It is essential that instrumentation specialists be trained and developed who will seek progress in this field for its own sake and thereby will form the corps of technical experts who can provide a multiple service to the other sciences.

From a talk entitled "Instrumentation: Where We Stand" presented at the 61st Annual Meeting of the American Society for Testing Materials, Boston, June 1958.

STATIC BALANCING ON A PRODUCTION BASIS

By NORMAN D. LAWLESS
AC Spark Plug Div.
General Motors Corp.
Flint, Mich.

INCLUDED in the speedometer assembly for an automotive vehicle is a small rotating component, called a drag cup, which performs the function of moving a pointer to indicate the speed of the vehicle. This shallow-drawn aluminum cup is attached axially to the spindle of the speedometer pointer, *Fig.* 1.

A permanent magnet, driven by a cable assembly geared to the transmission, rotates inside the cup and exerts a magnetic drag on the cup. Resulting eddy currents induced in the cup provide torque to move the pointer. Torque is in direct proportion to the speed of rotation of the permanent magnet.

To obtain a straight-line calibration of vehicle speed

versus pointer deflection, and to reduce pointer oscillation due to car bounce, it is essential that the drag cup be balanced statically prior to placement in the speedometer assembly.

Pre-Automation Methods

The original method for balancing drag cups was to use a manually operated fixture to punch one calibration hole in the cup and then machine another hole of larger diameter at the bottom of the cup in its rest position. The second hole was machined to just the correct depth to balance the cup. The depth was determined as a function of the angular rotation of the cup after the calibration hole had been punched.

Because of mechanical difficulties associated with this balancing method, the original fixture was replaced by one which punched three holes of the same diameter at a constant radius around the rim of the drag cup. However, the quality of static balance attainable was dependent entirely on the skill and judgment of the operator.

This fixture served satisfactorily until a recent need

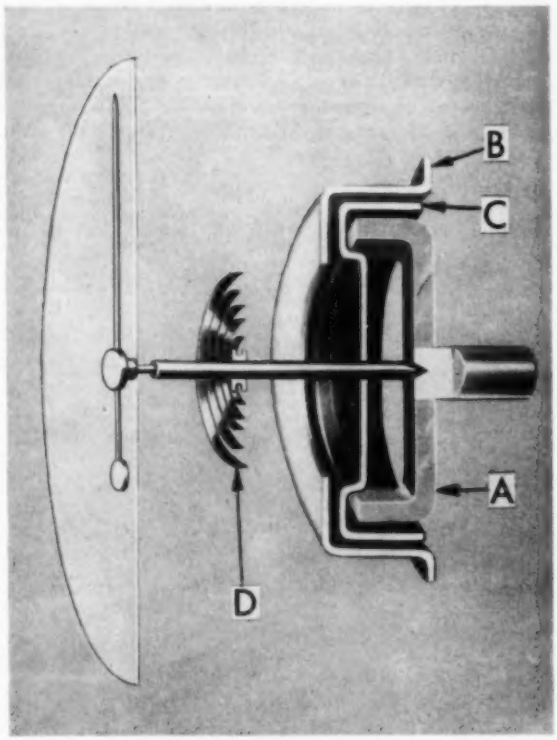

Fig. 1—In a speedometer, a rotating permanent magnet A works in conjunction with a stationary field plate B to set up eddy currents in a rotatable nonmagnetic drag cup C. The torque induced in the drag cup overcomes the resisting torque of a hairspring D so that the pointer is displaced in proportion to speed of the permanent magnet. It is necessary to balance the speed cup to obtain straight-line calibration of vehicle speed versus pointer deflection and to reduce pointer oscillation due to car bounce.

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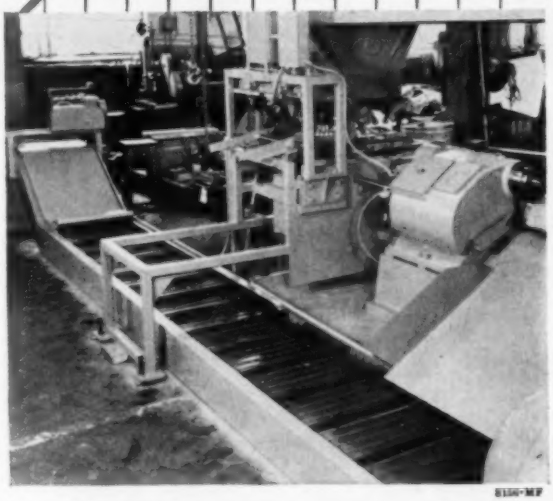

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Circle 722 on Page 161

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2	Chrome Alloy Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Steel Ball	For types operating under normal loads with minimum friction requirements.

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Circle 723 on Page 161

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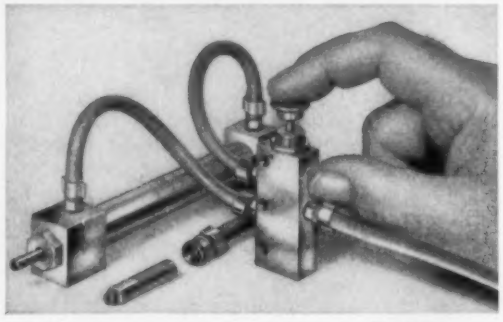

NEW more powerful 9/16" bore spring return and double acting MINIATURE Air Cylinders to complement our widely used 3/8" bore cylinders. NEW 4-way Air Valve, Quick Connects, A.C. and D.C. Solenoids, fittings, mountings and other needed items to improve your automatic tooling and production devices or new end products. Made for MILLIONS of cycles of trouble-free operation! Modestly priced.

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developed for increasing the rate at which drag cups could be balanced. Using the experience gained from the two previous fixtures, AC engineers set out to develop a fixture that would perform the static balancing operation automatically and also remove the effects of human error. The result was a static balancing fixture, *Fig.* 2, which automatically corrects the original unbalance of drag cups without the need for measurements or computations.

Improved Fixture

Using the new balancing fixture, static balancing of a drag cup includes six basic steps, *Fig.* 3. A drag cup to be balanced is first supported on electrically vibrated bearing supports so that it is free to rotate and come to rest with the heavy point of unbalance at the bottom. The original unbalance of the cup is then changed by making, in sequence, two corrections in the form of punched holes. These two corrections either increase the unbalance or decrease it to a known range.

Cups that have had their unbalance reduced as a result of the punching of the first two holes are finally balanced by the punching of a third hole at the bottoms of the cups in their rest positions.

If a cup rotates less than 70 degrees after the first hole is punched, it cannot be balanced in one operating cycle. Such cups are left in the fixtures for another balancing operation. Indicating pointers associated with the fixtures inform the operator of such

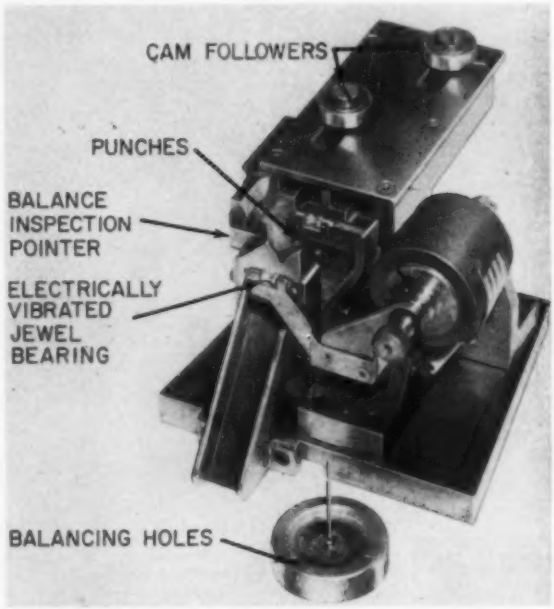

Fig. 2—Balancing fixture, one of 18 mounted on turntable of automatic balancing machine of Fig. 4, supports drag cups by their spindles on electrically vibrated jewel bearings. Punches, actuated by cam-operated slides, remove metal to balance the cups statically. Position of the first hole with respect to a pointer indicates whether satisfactory balance exists.

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cases. However, very few drag cups require recycling.

Perfect balance for all drag cups cannot be attained with the fixture. The last hole punched corrects only for the mean value of unbalance. However, the maximum unbalance error possible is equal to 0.000026 oz-in., and since the limit of unbalance of a drag cup for satisfactory operation in a speedometer is 0.0001 oz-in., cups are balanced to tolerances well within requirements.

Automatic Balancing Machine

After the design of the fixture was completed the next step was to devise a method for the production balancing of drag cups. The equipment that was developed, *Fig.* 4, includes 18 of the new-type balancing fixtures mounted on a continuously rotating turntable. Drag cups are loaded and unloaded manually, and the correction holes are punched automatically as the table rotates. The few drag cups that require another circuit through the machine are left in place in the fixtures by the operator.

Conventional automatic systems for static balancing require that the location and magnitude of original unbalance be determined by measurement. Methods used employ rotation or weighing of the part. The required amount of correction is then computed and applied to the part being balanced. With the new fixture the orginal unbalance of the drag cup is corrected without the need for measurements or computations. The three correction holes are automatically

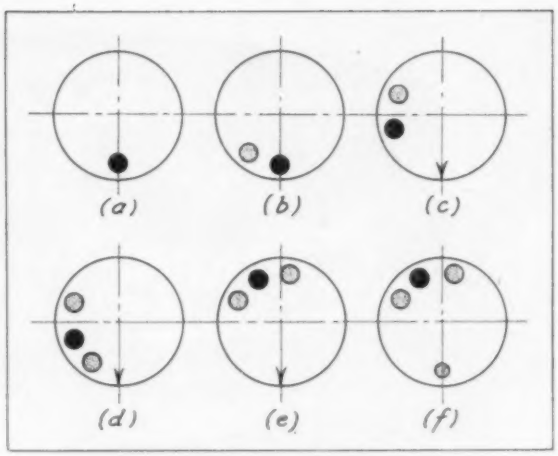

Fig. 3—Static balancing of speedometer drag cups is accomplished in six steps. An unbalanced cup, placed in the fixture of Fig. 2, is allowed a 10-second interval in which to come to rest with its heavy point down (a). A 0.136-inch diameter hole is then punched in the cup at an angle of 30 degrees from the bottom (b). After another 10-second interval the cup comes to rest in a new position (c). At (d) the 0.136-inch diameter punch is actuated a second time to produce another hole in the cup in a position 30 degrees from the bottom. When the cup assumes a new position (e) after a third 10-second interval, a 0.102-inch diameter hole is punched at the bottom of the cup (f).

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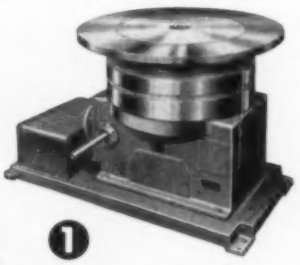
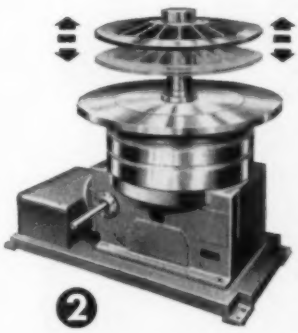


❶ *Series M chassis less optional accessories, showing 4" diameter center access hole, stationary center plate, ribbed turret, radial tool mounting surface, index camshaft extensions, jackshaft hole, drive housing and floor base.*



❷ *Series M chassis shown with vertically actuated overhead ribbed and cast tool mounting plate.*

❸ *Typical examples of operational tooling mounted to and mechanically actuated from the overhead tool plate.*

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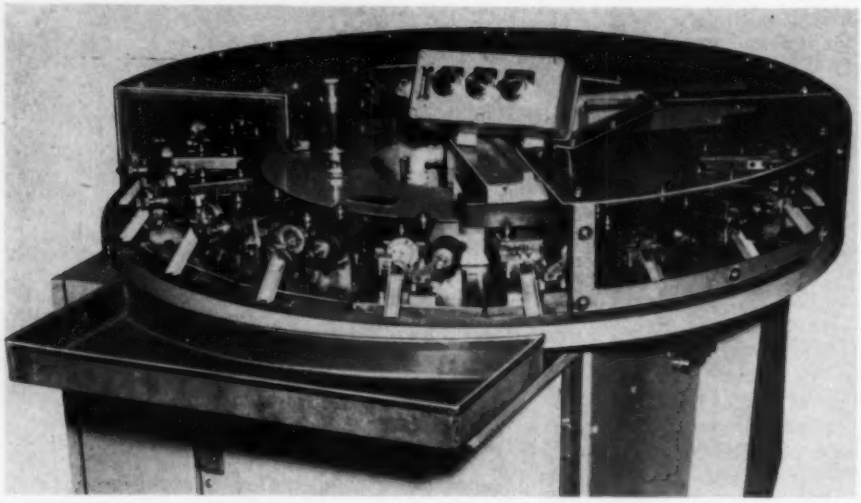

Fig. 4—Automatic drag cup balancing machine includes 18 balancing fixtures of the type shown in Fig. 2 mounted on a rotary turntable. Drag cups are manually loaded and unloaded. As the table rotates, stationary cams actuate the fixture slides to punch holes in the cups at predetermined locations. Spacing of the cams is such as to allow a 10-second interval for cups to come to rest between operations.

punched in the proper locations because of the self-positioning action of the drag cup as it is allowed to come to rest.

Balancing is achieved on a production basis by employing a number of balancing fixtures on a continuously rotating turntable. Because of the simplicity of design of the machine, and the fact that no electronic or mechanical measuring devices are used, operation is dependable and results are consistent.

Although the balancing fixture and the automatic machine were developed specifically to balance speedometer drag cups, they might easily be adapted for static balancing of a number of other types of small parts such as flywheels and gyros.

From an article entitled "Manufacturing Engineers Develop New Method To Statically Balance Speedometer Drag Cups" which appeared in the General Motors Engineering Journal, Vol. 5, No. 1, Jan.-Mar. 1958.

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TRANSISTOR ELECTRONICS OUTLOOK

By WILLIAM SHOCKLEY
Director, Shockley Semiconductor Laboratory
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A FEW MONTHS more than a decade have elapsed since the first point-contact transistor, produced by John Bardeen and Walter Brattain at Bell Telephone Laboratories, was made to oscillate, thus proving it had power gain. Where may we expect transistor electronics to go?

Looking ahead, certain trends are clearly seen, others are uncertain, and it is most probable that some important developments are not yet conceived. Trends that are sure to occur are increased reliability, better uniformity, and decreased cost. These are inevitable consequences of the increasing production of transistors which is more than doubling every year and will probably continue at this rate for at least 3 or 4 years more.

Another trend is toward decreased dimensions and higher frequencies. This trend is already occurring and can be predicted to continue, since the limits set by the atomic structure have not yet been even closely approached. It is probable that the achievement of higher frequencies will parallel the history of vacuum electronics.

Other uses of imperfections may enter the picture. Ionization of impurities by electron collision has been explored as a means of making analogs to gas-discharge devices.

Dislocations may play important roles in several ways. The reduction of carrier lifetime by high densities of dislocations may improve the performance of high-speed diodes.

Another trend which seems to me to be probable is the development of a limited number of commercial suppliers of semiconductor crystal material. Such suppliers would play a role similar to the manufacturers of vacuum pumps in conventional electronics. Such a development would be well worthwhile if it could supply a substantial portion of the industry.

With higher degrees of perfection in crystalline material—and this is sure to come in one way or another—will come ease of fabrication of larger and higher voltage devices. Thus, the high power field should become accessible to semiconductor devices. I do not think it fantastic to suppose ordinary domestic switches may in time be replaced by remotely controlled transistor circuits without any moving metal contacts.

It is evident that many years of exciting developments lie ahead in the field of transistor electronics. It now seems likely that basic physical knowledge is building up faster than it is being exploited. If any area is weak, it seems to me to be along the borderline between exploratory research, with knowledge as an adequate goal, and development for production, with the aim of finding a useful production process. I believe the field would advance faster if somewhat more fundamental understanding were sought for the processes likely to be useful in production.

From a talk entitled "Whither Transistor Electronics?" presented at the 1958 *Transistor and Solid State Circuits Conference co-sponsored by the IRE, AIEE, and University of Pennsylvania, Philadelphia, Feb.* 1958.

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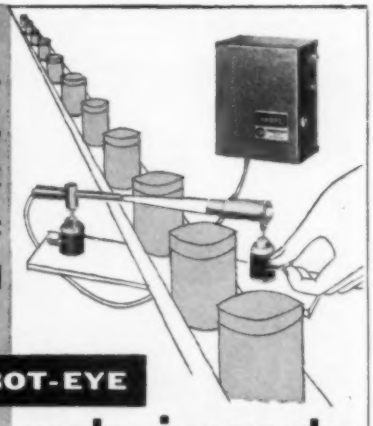

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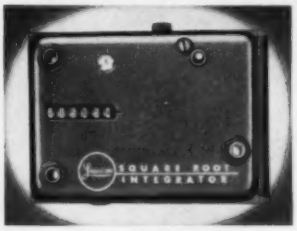

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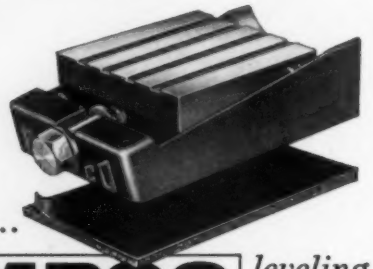

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ARTICLE HANDLING APPARATUS

Magnetic article moving through a nonmagnetic tubular element is arrested by a magnetic field until field is deenergized, releasing article. Patent 2,823,781 by Robert E. Bosch, assigned to General Electric Co.

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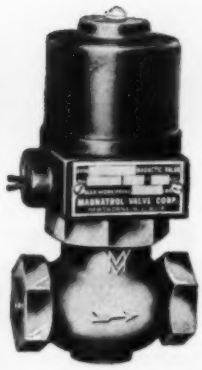

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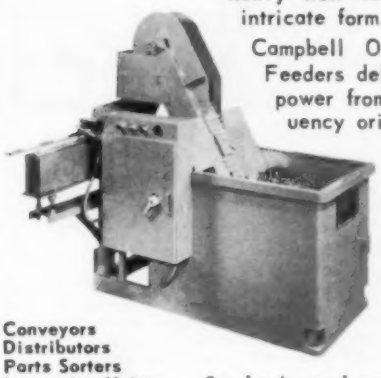

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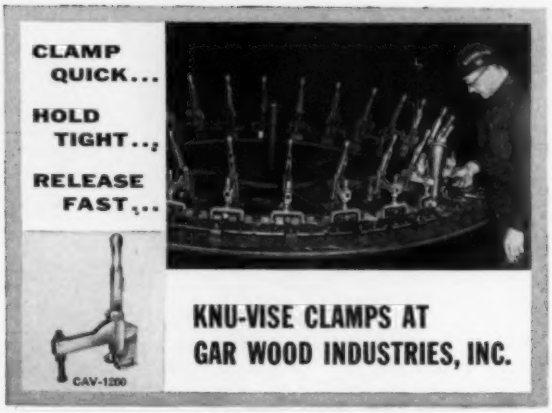

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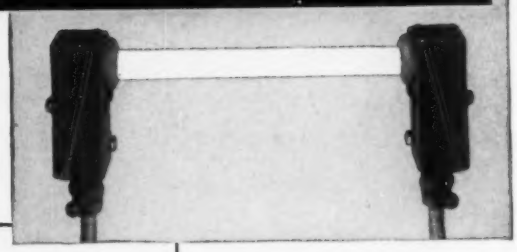

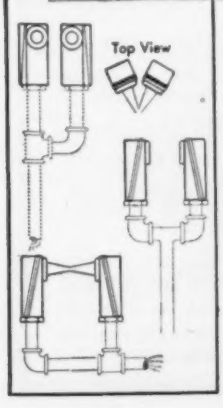

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TECHNIQUES OF PRESSWORKING SHEET METAL

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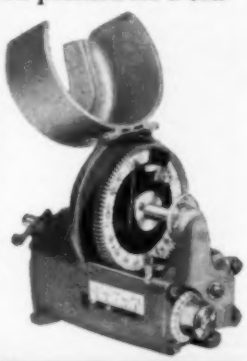

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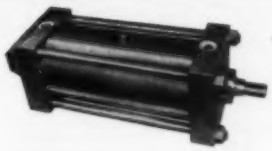

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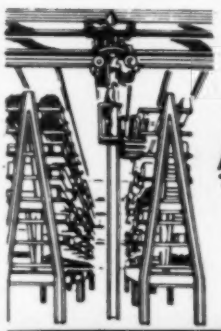

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AUTOMATION problem forum

Readers with problems concerning systems, equipment or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Solution suggestions should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

Case 1607-P
Conveyor System Wiring

. . . We are planning to install a conveyor system for loading bags. (12 separate conveyors to be installed in series fashion in a straight line; each conveyor to have its own drive motor; bags to be dropped on 6 center units for discharge at either end.) The 6 units in the center will have reversing magnetics so they can be made to go either direction; 3 units on each end will run only one direction. My problem is to put in a control panel where all motors can be started in proper direction and have an *ON-OFF* control near the last two units at each end. It is also desirable to have all motors toward source of bags cut off in case of any motor kickout. I would like a schematic diagram for motor connections to serve this type of problem. . .

Plant Equipment Man

♦ ♦ ♦

Suggestions for 1504-P (May 1958)
Carton Counting

. . . If it is possible for your reader to place a small piece of aluminum foil on the carton so that our pickup could detect this foil, then I think we could be of assistance. . .

R. C. Crossley
Electro Products Laboratories

♦

. . . Our Model P-1 counter, as described on the attached sheet, has a preset range of from 1 to 10. The counter may be pulsed either photoelectrically or by switch contacts. . .

Lawrence A. Tibbetts
Post Machinery Co.

♦

. . . The problem could be solved by using one of the following methods: 1. If cartons are spaced apart and could exert a 1-oz force as they pass, a lever type limit switch could be used to energize a stepping switch, so that at every 8th impulse a solenoid would move the 8th box as desired. 2. If cartons are spaced apart but would be moved by the limit switch lever, a photoelectric relay could be substituted for the limit switch. 3. If cartons are jammed together a limit switch could be set up 8 carton lengths beyond a solenoid so that a signal at front of line would energize solenoid at rear. Switch and solenoid would have to be mounted on same side of conveyor.

Methods 1 and 2 would be more reliable since they count boxes not length, and would be accurate even if a carton should fall flat so long as a small space between cartons remained. . .

A. E. Farr
Wheelabrator Corp.

♦

. . . We are interested in this problem and feel confident that we can provide suitable equipment for its solution. . .

Dana N. Fisher
Electronics Corp. of America

♦ ♦ ♦

Suggestions for 1543-P (July 1958)
Tube Cutting

. . . We specialize in manufacturing automation equipment and handling systems for bar and tube processes. Will you put us in touch with the interested party. . .

Joseph H. Spurgeon
Spurgeon Co.

♦

. . . We would be happy to work with your reader. This project appears to be very similar to one which we have handled previously. . .

J. R. Humphrey
Humphrey Design Co.

♦ ♦ ♦

Suggestions for 1528-P (July 1958)
Closed Circuit TV

. . . I am enclosing a copy of our basic brochure, "How Many Jobs," which describes many of these applications; and if we could be of additional assistance, we should appreciate receiving pertinent information. . .

E. J. Manzo
General Precision Laboratory Inc.

♦

. . . I am enclosing technical literature which will be of some assistance to your reader. I would be pleased to learn more details about the problem so that I can be of more assistance. . .

Richard E. Lontka
Blonder-Tongue Laboratories Inc.

Suggestions for 1522-P (July 1958)
Press Feeding

. . . We suggest that the case be referred to Planet Corp. for information on their Planobot. . .

John M. Graham
Graham & Associates

♦

. . . To obtain a proposal of our approach to this problem, we need only the following: Operation description, size and weight of parts, rate of production, type of presses, sketch of plant area involved. . .

Robert L. Bowdy
Michigan Production Engineering Co.

♦

. . . A dial feed might be of help. A dial feed reduces the hazard as the operators never have to put their hands under the dies. . .

B. W. Perkins
Perkins Machine Co.

♦

. . . Attached are sheets on equipment of our manufacture. We would suggest that the reader contact us for more detailed information. . .

M. A. Campbell
Campbell Machines Co.

♦ ♦ ♦

Suggestions for 1510-P (June 1958)
Assembly of Darts

. . . We would like to discuss the automation of this assembly with the manufacturer who submitted this case. . .

E. M. McConnell
Textile Machine Works

♦

. . . We specialize in building automatic assembly machinery for the wood case pencil manufacturers as well as ball point pen manufacturers, and we believe that we could be of service. . .

Ray Conner
Acorn Pencil Co.

♦

. . . We are very much interested in work of this type as our shop is equipped to do a complete job of designing and building automatic equipment. . .

H. N. Overtoom
American Can Co.

♦

. . . We have manufactured similar machines and would gladly assist in the design and manufacture of a completely automatic machine for this operation. . .

F. A. Kellner
Carborundum Co.

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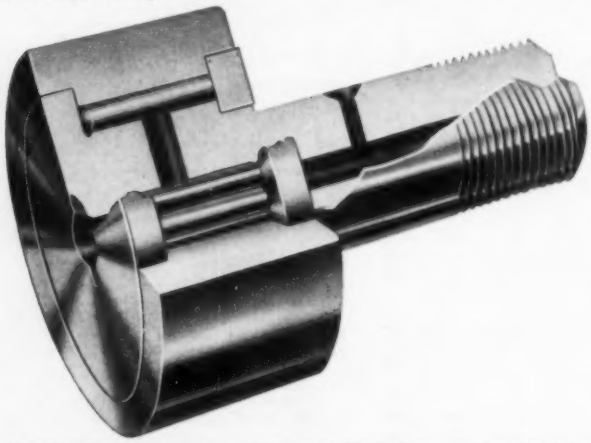
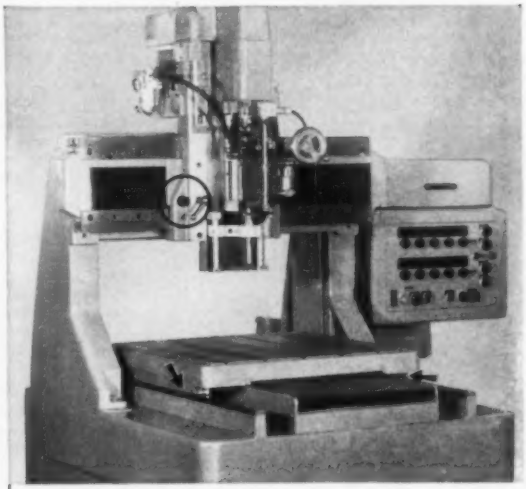
AUTOMATION TIPS
by McGill

CAMROL® bearings... provide automated machinery with precision anti-friction - extra capacity - longer life

Specify CAMROL cam followers where you need dependable, maintenance free bearing performance in automated machine operation. They offer engineered precision with extra protection against jolting wear and excessive loading.

Built especially for cam, guide, support or track roller applications, the McGill cam follower provides free rolling action, positive side thrust and low starting friction — all available in roller sizes from ½" to 4". Order the CF (with stud) and CYR (for shaft mounting) sealed for positive protection.

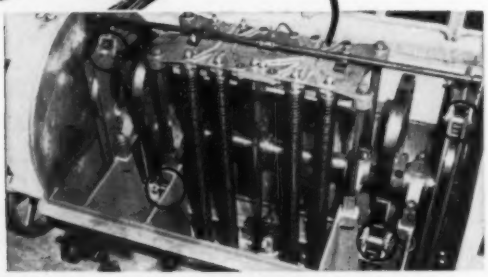




Sealed CAMROL Bearings as table and crosshead rollers in tape-controlled Hillyer drilling machine

CAMROL bearings provide smooth, accurate motion as load carrying rollers for table and crosshead motion of this tape-controlled, precision drilling machine manufactured by Hillyer Corporation. Use of the sealed CAMROL bearings has greatly simplified construction and improved accuracy. They have eliminated the manufacture of shaft and retainer assemblies and increased load capacities. The corrosion resistant finish of the SCF series bearings has also eliminated the need for plating the bearings. Ball bearings formerly used in this application cracked under the same loads. High accuracy of shaft and bearing concentricity eliminates the need for separate adjustments. Operating speeds are 400 RPM and loads are 2000 pounds. The bearings are prelubricated and sealed to keep maintenance at a minimum.

CAMROL bearings take cam action shock in FMC juice extractors



The Food Machinery and Chemical Corporation In-Line Juice Extractor uses McGill CYR-3 bearings as cam followers on the vertically reciprocating beam that carries cups for squeezing juices from citric fruits. A large cam having an 11" total throw drives against the bearings, moving the beam downward. The CYR 1½ cam followers are used to pull another beam upward. The upstroke is a power stroke with 6" total throws.

Both cam followers have stood up exceptionally well. Many have been in the field for 6 years and operated 20,000 hours, or the equivalent of at least 48 million strokes.

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precision needle roller bearings

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Airless Abrasive Blasting

Wheelabrator Corp., 490 S. Byrkit St., Mishawaka, Ind.—28 page handbook—Different types of cleaning and finishing equipment are outlined in Catalog 143-D. Cleaning method is explained, aided by a cutaway photo showing the components in position. Units described are suitable for operations such as forging and stampings, finishing, reconditioning, and steel descaling. Special cabinets, designed for handling work which is not adaptable to a standard machine, are also mentioned.

Circle 492 on Page 161

Parts Handling & Storage

F. Jos. Lamb Co., 5663 E. Nine Mile Rd., Detroit 34, Mich.—16 page booklet—System is described in Bulletin 58-01, which consists of individual units that are integrated into production operations to function the same as large transfer units. A schematic diagram aids in the explanation of the system, which is constructed with reusable components. Advantages are noted and data on the steps in the operation are given. Various floor arrangements for different applications are suggested.

Circle 493 on Page 161

Equipment Leasing

U. S. Leasing Corp., 130 Montgomery St., San Francisco 4, Calif.—16 page booklet—Booklet contains an analysis of equipment leasing in comparison to other means of financing equipment acquisitions. Various case histories show advantages of leasing. Suggestions are given on how to enter into a lease program and the costs involved are discussed.

Circle 494 on Page 161

Continuous Mixers

Chemical Machinery Div., Baker Perkins Inc., 1000 Hess, Saginaw, Mich.—8 page bulletin—Continuous mixers, which can be used to mix various chemicals, plastics, and explosives, are described in Bulletin K-57. Specifications and advantages are listed. Also discussed are problems encountered in continuous mixing in the chemical field.

Circle 495 on Page 161

Spherical Bearings & Rod Ends

Sealmaster Bearing Div., Stephens-Adamson Mfg. Co., Aurora, Ill.—10 page bulletin—Data on spherical bearings and rod ends are contained in Bulletin 257. Design and construction of the units is explained and applications noted. This special type of bearing does not supplant antifriction bearings, rather it fills the need for a bearing that permits considerable misalignment in oscillatory applications.

Circle 496 on Page 161

Ball Bearing Trolleys

Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.—20 page booklet—Ball bearing trolleys, their types and sizes are described in Bulletin 2636. Data on the selection of new trolleys and attachments and the replacement of units in existing installations, are given. Construction features and maintenance suggestions are noted.

Circle 497 on Page 161

Variable Speed Control

U. S. Electrical Motors Inc., P. O. Box 2058, Terminal Annex, Los Angeles 54, Calif.—8 page bulletin—Operation and application of a variable speed drive with pneumatic control system are described in Bulletin F-1882. Illustrations of applications, which include weight control, humidity control, heat control, and pressure control, are given. Notes are included on how precise speeds of any selection can be set up and automatically maintained with these units. Data on the instrumentation package are also given.

Circle 498 on Page 161

Analog Computer Study

Electronic Associates Inc., Long Branch, N. J.—6 page bulletin—One phase of a transistor production cycle is described in Bulletin 5. It describes the technique of simulating on the analog computer the conditions experienced by a germanium rod under varying conditions of temperature, rod diameter, and length of molten zone. Also included is a chart listing the different symbols used on a general purpose analog computer for the problem.

Circle 499 on Page 161

Liquid Level Controls

Photoswitch Div., Electronics Corp. of America, One Memorial Dr., Cambridge, Mass.—16 page booklet—Data on electronic and electromagnetic controls are contained in Bulletin PF571. Features, such as low probe voltage, selection of probe types and materials, and universal supply voltages are described, and charts list specifications and dimensions. Guide is given for the selection of the appropriate control system for liquid level applications.

Circle 500 on Page 161

Polishing and Buffing Machines

Acme Mfg. Co., 1400 E. 9 Mile Rd., Detroit 20, Mich.—16 page booklet—Data on line of automatic polishing and buffing machines are given. Factors to consider when selecting machines for a variety of applications are discussed. Sketches show the positions of parts in relation to polishing wheels at different stations. Various types of adjustable lathes which can be used in conjunction with the polishing machines are also mentioned.

Circle 501 on Page 161

Metal-Ceramic Items

Haynes Stellite Co., Div., Union Carbide Corp., Kokomo, Ind.—12 page booklet—Units composed of metal-ceramics are described, such as thermocouple protection tubes, mechanical pump seals, flame guardian rods, and molten metal control pins and spouts. Physical, mechanical, and chemical properties are explained and temperature ranges given. The sizes, shapes and configurations that are available are discussed.

Circle 502 on Page 161

Drilling & Tapping Units

Hypneumat Inc., 647 W. Virginia St., Milwaukee 4, Wis.—28 page catalog—Data on drilling and tapping units for the metalworking industry are contained in Bulletin 5810. A cutaway view shows the different components which comprise the basic unit. Drill thrust charts are listed and schematic drawings show valve operations and air tapping operations.

Circle 503 on Page 161

Frame Grid Tubes

Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.—12 page booklet—Frame grid tubes, which are applicable in data processing equipment, production control equipment, and test and measuring equipment, are described in Bulletin PQ658. Composition and construction of the tube are explained and data are given on the three different types available. Charts show performance curves, and life expectancy.

Circle 504 on Page 161

Strain Gage Measurements

Datran Electronics, 1836 Rosecrans Ave., Manhattan Beach, Calif.—4 page pamphlet—Brochure titled "The Resistance Bridge Indicator and Its Applications" covers the various applications of the instrument which can be calibrated to indicate directly

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in microinches of strain, psi, pounds, and ft-pounds. Also discussed is how the instrument, when supplied with an analog to digital shaft converter, becomes the heart of a multichannel automatic digital recording system. Schematic diagrams illustrate the different operations.

Circle 505 on Page 161

Cubled Tubes

Crescent Insulated Wire & Cable Co., Trenton 5, N. J.—12 *page booklet*—Cabled pressure tubes for instruments and controls are described in Bulletin 458. Data are given on the various types of tubing, the protective armor and types of corrosion-resistant sheaths. Instructions for installation are noted. Also included are illustrations of tubes for indoor and outdoor use, and accessories such as terminal fittings, junction boxes, and clamps.

Circle 506 on Page 161

Enclosed Conveyor

Prab Conveyors Inc., 30121 *Groesbeck Hwy., Roseville, Mich.*—9 *page bulletin*—Enclosed bulk material handling conveyor, which features a two-directional chain to convey in any direction, is the subject of Brochure TV-80. The continuous operation that removes chips and scrap material from machine tools, is described. Application photos are given.

Circle 507 on Page 161

Adjustable Speed Drives

Cutler-Hammer Inc., 378 *N.* 12th *St., Milwaukee* 1, *Wis.*—12 *page booklet*—Line of adjustable speed drives, designated Ultraflex E, is described in Bulletin EN-64. The unit, which uses electronic tubes for power conversion, is available in sizes from 1 to 40 hp. Composition of the power conversion units, protective system, control stations, and motors are explained and illustrated.

Circle 508 on Page 161

Roller Coaters

Union Tool Corp., Warsaw, Ind.—6 *page pamphlet*—Booklet outlines five models of roller coaters suitable for applying all types of coatings on any flat material. Components of the basic unit are described, and sketches show the difference in the styles.

Circle 509 on Page 161

Tank Weighing System

A. H. Emery Co., Pine St., New Canaan, Conn.—12 *page booklet*—Load cells and accessory equipment for indicating, recording, printing, and controlling operations, are described in Bulletin 581. Construction and function of the Emery load cell, which is the heart of the tank weighing system, is explained, aided by schematic drawings. Suggested arrangements for different applications are included.

Circle 510 on Page 161

Production Grinders

Mattison Machine Works, Rockford, Ill.—12 *page booklet*—Line of precision grinders and foundry grinders is outlined. Factors to consider in selecting a grinder are noted. Construction features are mentioned and the design of the self-contained grinding heads is also explained.

Circle 511 on Page 161

Industrial Servo Data

Kearfott Co. Inc., 1500 *Main Ave., Clifton, N. J.*—3 *data sheets*—Units applicable in industrial servo systems and industrial control systems are covered in data sheets. Specifications and schematic drawings of 60 cycle synchros and a 60 cycle servo motor generator are given. Third data sheets list features, mechanical, and electrical characteristics for a transistorized servo amplifier for 60 cycle applications.

Circle 512 on Page 161

Hydraulic Cylinders

Hanna Engineering Works, 1765 *Elston Ave., Chicago* 22, *Ill.*—8 *page bulletin*—Hydraulic cylinders, with pressure ranges from 2000 to 3000 psi, are described in Catalog 900. Features of the units are outlined, and mounting dimensions and cylinder capacities are listed. Sketches show the different styles available.

Circle 513 on Page 161

Process Equipment

B-I-F Industries Inc., 345 *Harris Ave., Providence* 1, *R. I.*—12 *page booklet*—Equipment used in process industries, such as meters, feeders, controls, blenders, and filters, is outlined in Bulletin B-I-F 5. Data are also given on accessories such as lime slakers, bucket elevators, dust collectors, and dissolving chambers.

Circle 514 on Page 161

Temperature Controls

United Electric Controls Co., 79 *School St., Watertown* 72, *Mass.*—8 *page bulletin*—Data on temperature controls are given in Catalog 400. Items described include general purpose, dual switch, explosion-proof, and indicating type units, both mounted and remote-controlled. Variations and features distinguishing the rigid thermal element and bulb styles are mentioned. Special purpose temperature controls are also discussed.

Circle 515 on Page 161

Oil Refining Contractor

Southwestern Engineering Co., 4800 *Santa Fe Ave., Los Angeles* 58, *Calif.*—8 *page bulletin*—Factors involved in choosing a contractor for the design and construction of an oil refinery are discussed in Bulletin E-581. Company's manufacturing and engineering facilities are described and illustrations show completed projects.

Circle 516 on Page 161

Solenoid Valves

Automatic Switch Co., 50-56 *Hanover Rd., Florham Park, N. J.*—8 *page bulletin*—Descriptions of 2-way, 3-way, and 4-way valves are given. Features and applications are noted. Miniature solenoid valves are also mentioned. Data are included on multiple mounting of 2 and 3-way valves with a manifold design.

Circle 517 on Page 161

Fluid Power Circuits

Logansport Machine Co. Inc., Logansport, Ind.—28 *page catalog*—Booklet contains air and hydraulic circuits covering sequencing, semiautomatic, and automatic cycling, dual pressure systems, safety systems, skip feed arrangements, and synchronization of two cylinders. Charts list an explanation of the JIC symbols used in the diagrams. The sequence of operation for all the arrangements are described.

Circle 518 on Page 161

Rotary Tables

Pratt & Whitney, 505 *Oakwood Ave., West Hartford* 1, *Conn.*—24 *page handbook*—Data are contained in Bulletin 619 on precision rotary tables for inspecting, machining, and graduating operations. The unit featuring automatic indexing is described and illustrated. Functions and features of the three styles—horizontal, vertical, and tilting—are discussed.

Circle 519 on Page 161

Blowers & Exhausters

Miehle-Dexter Div., Miehle-Goss-Dexter Inc., 100 *Fourth St., Racine, Wis.*—6 *page pamphlet*—Data are contained in Bulletin 581 on line of rotary positive industrial blowers and exhausters with pressures ranging up to a maximum of 14 psig in single-stage and to 70 psig in multistage types. Advantages in using the blowers for pneumatic conveying are noted. Other uses, such as expansion motors to drive accessories and metering devices, are listed.

Circle 520 on Page 161

Standby Power

Industrial Div., Gould-National Batteries Inc., Trenton 7, *N. J.*—12 *page booklet*—Data is contained in Bulletin GB 1848 on calcium stationary batteries with capacity ratings from 50 to 1140 amp-hour. Applications include use for switch gears, alarm systems, signalling, emergency light-

ing, and similar operations where batteries are used for standby power. Suggestions on how to calculate the size of a battery are given. Specifications and installation instructions are included for the units.

Circle 521 on Page 161

Wire Rope Conveyor

Joy Mfg. Co., Oliver Bldg., Pittsburgh 22, Pa.—2 page pamphlet—Method of constructing supports for belt conveyor systems with steel wire rope is explained in Bulletin GG-6C. Notes on installation, costs, belt life and maintenance are given. Sketch illustrates construction features.

Circle 522 on Page 161

Electrical Control

Assembly Products Inc., 75 Wilson Mills Rd., Chesterland, Ohio—12 page booklet—Electrical units, which control thickness, torque, current, voltage, pressure, viscosity, speed, and load, are outlined in Bulletin 106A. The Load Sentry, which protects motors, tools, and dies against overload, is described and illustrated. Various sketches show the control actions of the different units.

Circle 523 on Page 161

Tachometer Generator Report

Servo-Tek Products Co., 1086 Goffle Rd., Hawthorne, N. J.—12 page report—Test procedures and test equipment used in determining the stability, linearity, and other characteristics of dc tachometer generators, are reported in Bulletin 161. Some of the points discussed are temperature effects, overload effects, brush life, and high altitude operation.

Circle 524 on Page 161

Press Brakes

Taylor-Winfield Corp., Warren, Ohio—8 page bulletin—Press brakes, which are applicable in bending, blanking, drawing, forming, and trimming operations, are outlined in Bulletin 13-693. Features are noted and design advantages explained. Charts list force required to bend mild steel for various thicknesses of metal under various conditions.

Circle 525 on Page 161

Speed Reducers

Cleveland Worm & Gear Co., 3249 E. 80th St., Cleveland 4, Ohio—8 page bulletin—Data on line of worm gear speed reducers are contained in Bulletin 150. Construction design and lubrication system is explained. Illustrative examples of various applications are given.

Circle 526 on Page 161

Data Conversion

Epsco Inc., 588 Commonwealth Ave., Boston 15, Mass.—6 page pamphlet—Line of modularized, transistorized, analog-to-digital converters, digital-to-analog con-

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verters, and alarm limit monitors, is outlined. Specifications and features are listed and diagrams show the operation of the units.

Circle 527 on Page 161

Pneumatic Components

Clippard Instrument Laboratory Inc., 7390 Colerain Rd., Cincinnati 39, Ohio—4 page pamphlet—Data on miniature pneumatic cylinders, valves, solenoids, manifolds, fittings, and accessories are contained in Bulletin MA-25. Applicational photographs are included.

Circle 528 on Page 161

Metal Marking

M. E. Cunningham Co., 1025, Chateau St., Pittsburgh 33, Pa.—4 page pamphlet—Data are given on remotely-controlled slab and bloom markers, double-headed slab markers, and consecutive-numbering billet markers. Illustrations show the remote-control unit in operation.

Circle 529 on Page 161

Grinder Control Equipment

Airborne Instruments Laboratory Inc., 1345 New York Ave., Huntington Station, N. Y.—13 page booklet—Microtrol, Type 150, an instrument designed for size-control use on external plunge grinders, is the subject of booklet. Operations and advantages of the instrument are explained. The three models, which are available, are described and illustrated. Data on the accessories, which provide automatic control, are also given.

Circle 530 on Page 161

Ultrasonic Cleaners

Wilmot Castle Co., 1920 E. Henrietta Rd., Rochester, N. Y.—6 page pamphlet—Line of individual cleaners and dryers, combination cleaner-dryers, and laboratory portable units, is outlined in Bulletin H246. Function of the unit is explained and illustrations show the operation cycle.

Circle 531 on Page 161

Gravity & Power Conveyors

Metzgar Conveyor Co., Dept. R. C., 412 Douglas St., N. W., Grand Rapids 4, Mich.—49 page catalog—Data on line of gravity (roller and wheel) and power conveyors are contained in Catalog 58. Charts list dimensions for straight sections, wheel, and roller curves, in both the aluminum and steel frames. Accessories, such as bases, stands, and portable mounts, are described.

Circle 532 on Page 161

Mechanical Force Gage

W. C. Dillon & Co. Inc., 14620 Keswick St., Van Nuys, Calif.—6 page pamphlet—Model X, a mechanical force gage for precision measurement of pressure, tensile, or torque, is described in Bulletin 11E. Construction of the instrument is explained, and charts list dimensions.

Circle 533 on Page 161

Heat Exchangers

Ross Heat Exchanger Div., American-Standard, Box 2081, Buffalo 5, N. Y.—8 page bulletin—Line of heat exchangers, suitable for use in the chemical industry, is described in Bulletin 302.5K1. A cutaway view shows the position of the components and sketches display the construction features. Design features are noted, and instructions for selecting the proper unit for a specific application are given.

Circle 534 on Page 161

Controlling Pyrometer

Illinois Testing Laboratories Inc., 420 N. LaSalle St., Chicago 10, Ill.—6 page pamphlet—Pyrotroller, an indicating-controlling instrument, is the subject of Bulletin 3885. Both indicator and controller specifications are noted and ranges and thermocouple alloys which are available are listed. Also given are wiring diagrams for electrically heated and gas or oil fired equipment.

Circle 535 on Page 161

Hobbing Machines

Cleveland Hobbing & Machine Co., 1311 Chardon Rd., Cleveland 17, Ohio—12 page booklet—Data on line of single spindle and rotary hobbing machine are contained in Catalog 600. The continuous automatic shifting hobhead is explained. Construction and operating features are noted and illustrated. Automatic orienting, loading, and unloading mechanisms are sketched.

Circle 536 on Page 161

Bushings and Hubs

Cullman Wheel Co., 1344 Altgeld St., Chicago 14, Ill.—4 page pamphlet—Bulletin 201 describes steel split-tapered bushings and weld-on hubs, which are applicable for shaft installations of sprockets, pulleys, sheaves, gears, and couplings. Dimensions, stock numbers, and prices are listed. The procedure for bushing installation and removal is given.

Circle 537 on Page 161

Measuring Valve System

Lincoln Engineering Co., 5794 Natural Bridge Ave., St. Louis 20, Mo.—4 page pamphlet—System is described in Bulletin 682, which dispenses measured quantities of fluid and semifluid materials in assembly operations. Data are given on different types of valves, such as high pressure measuring valves, four-way hydraulic control valves, and portable or stationary valves.

Circle 538 on Page 161

Cooler/Pasteurizer

Island Equipment Corp., P.O. Box 276, Miami 38, Fla.—4 page pamphlet—Cooler/pasteurizer applicable for jars, bottles, cans, and aerosol containers, is the subject of Bulletin JC-2. The three-stage cooling operation is explained, aided by sketches. The unit is constructed of 12-foot sections, each one independently operated. Suggested arrangements for the sections are offered.

Circle 539 on Page 161

Milling Machine

Producto Machine Co., Bridgeport 1, Conn.—8 page bulletin—Index Mill-Matic, an automatic production milling machine using the index method, is described. The different types of operations the equipment can perform are explained, and applicational photos shown. Also included are drawings showing the cross-section of the index mechanism and the index drive unit.

Circle 540 on Page 161

Cooling Clamps

Industrial Div., Birtcher Corp., 4371 Valley Blvd., Los Angeles 32, Calif.—16 page booklet—Data on seventeen types of cooling and retaining clamps for miniature and subminiature tubes and components are contained in Catalog 5-KK. Function of the unit is explained. The variety of designs, materials, and finishes which are available, are noted. Ordering instructions are also included.

Circle 541 on Page 161

Hydraulic Cylinders

Sheffer Corp., 326 W. Wyoming Ave., Cincinnati 15, Ohio—5 page pamphlet—Data on hydraulic cylinders, rated for pressures from 3000 to 5000 psi and with bore sizes from 2 to 12 inches, are contained in Bulletin 1258. The stressed tie-rod design is explained, as are other features. Schematic drawings show the front flange mount, rear flange mount, and pivot mount styles.

Circle 542 on Page 161

Pressure Testing Units

Mechanical Products Corp., 168 N. Ogden Ave., Chicago 7, Ill.—16 page booklet—Line of test plugs and filling connectors is described in Bulletin 658. The units are suitable for sealing openings for pressure testing. The self-sealing principle and the expanding-seal principle are explained and illustrations show the units available for irregular shaped openings. Application photos are given.

Circle 543 on Page 161

Dust Collectors

Torit Mfg. Co., 287 Walnut St., St. Paul 2, Minn.—16 page booklet—Equipment which collects grinding dust, rubber dust, carbon dust, sawdust, chips, and shavings is described in Catalog 39. Three styles of units are discussed—the cabinet cloth filter type for gritty dust, the cyclone separator type for bulky or sticky dust, and exhauster and blowers for fumes and gases. Performance characteristics and specifications are listed. Optional equipment and accessories are also mentioned.

Circle 544 on Page 161

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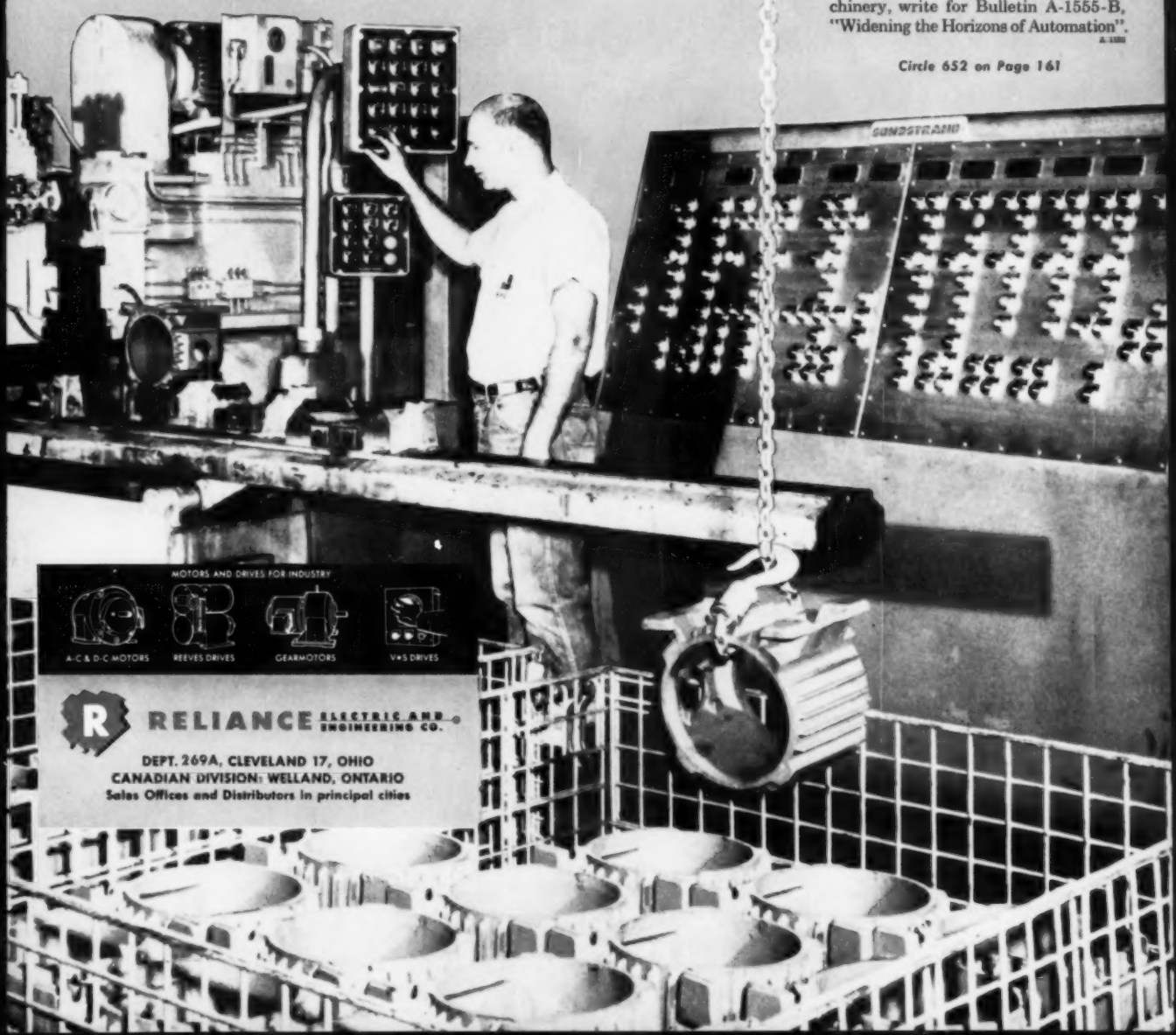
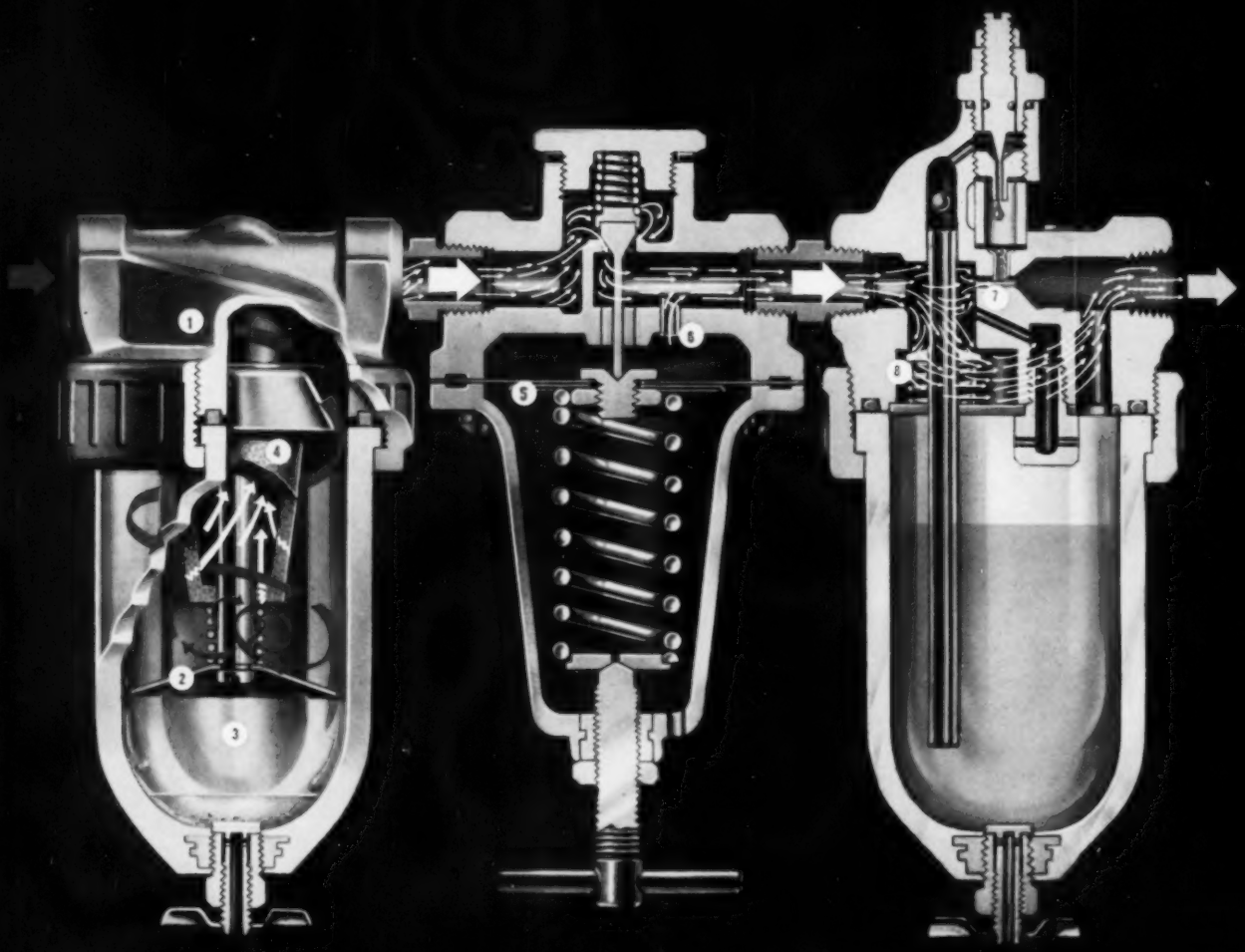
If you would like further information on Reliance Drives for any type of machinery, write for Bulletin A-1555-B, "Widening the Horizons of Automation".

Circle 652 on Page 161





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